**Universidade do Estado do Rio de Janeiro**
Centro Biomédico
Faculdade de Ciências Médicas

Fernando Serra Guimarães

# Avaliação volumétrica e funcional do músculo glúteo máximo submetido a gluteoplastia de aumento com implantes de silicone

Rio de Janeiro
2014

Fernando Serra Guimarães

**Avaliação volumétrica e funcional do músculo glúteo máximo submetido a gluteoplastia de aumento com implantes de silicone**

Tese apresentada, como requisito parcial para obtenção do grau de Doutor, ao Programa de Pós-graduação em Fisiopatologia e Ciências Cirúrgicas, da Universidade do Estado do Rio de Janeiro. Área de concentração: Técnica Operatória e Cirurgia Experimental.

Orientador: Prof. Dr. Ruy Garcia Marques

Rio de Janeiro

2014

CATALOGAÇÃO NA FONTE
UERJ/REDE SIRIUS/BIBLIOTECA CB-A

G963 Guimarães, Fernando Serra.
Avaliação volumétrica e funcional do músculo glúteo máximo submetido a gluteoplastia de aumento com implante / Fernando Serra Guimarães. – 2014.
131 f.

Orientador: Ruy Garcia Marques.

Tese (Doutorado) – Universidade do Estado do Rio de Janeiro, Faculdade de Ciências Médicas. Pós-graduação em Fisiopatologia e Ciências Cirúrgicas.

1. Cirurgia plástica - Teses. 2. Cirurgia plástica – Técnica - Teses. 3. Nádegas - Cirurgia - Teses. 4. Nádegas – Fisiologia - Teses. 5. Implante de Prótese. 6. Força muscular. I. Marques, Ruy Garcia. II. Universidade do Estado do Rio de Janeiro. Faculdade de Ciências Médicas. III. Título.

CDU 611.738.14:617.5-089.844

Fernando Serra Guimarães

**Avaliação volumétrica e funcional do músculo glúteo máximo submetido a gluteoplastia de aumento com implantes de silicone**

Tese apresentada, como requisito parcial para obtenção do grau de Doutor, ao Programa de Pós-graduação em Fisiopatologia e Ciências Cirúrgicas, da Universidade do Estado do Rio de Janeiro. Área de concentração: Técnica Operatória e Cirurgia Experimental.

Aprovada em 20 de agosto de 2014.

Orientador: Prof. Dr. Ruy Garcia Marques
Faculdade de Ciências Médicas – UERJ

Banca Examinadora:

_______________________________________________________

Prof. Dr. Carlos Alberto Mandarim-de-Lacerda
Faculdade de Ciências Médicas – UERJ

_______________________________________________________

Prof. Dr. Fabio Xerfan Nahas
Faculdade de Ciências Médicas – UERJ

_______________________________________________________

Prof. Dr. João Medeiros Tavares Filho
Universidade Federal do Rio de Janeiro

_______________________________________________________

Prof. Dr. Luiz Cesar Boghossian
Universidade Federal do Rio de Janeiro

_______________________________________________________

Prof. Dr. Pedro Bins Ely
Fundação Universidade Federal de Ciências da Saúde de Porto Alegre

Rio de Janeiro
2014

## DEDICATÓRIA

Aos meus Pais que me deram educação para que eu fizesse as escolhas certas.
Às minhas filhas, Eva e Maitê, para quem tentarei dar educação para permitir boas escolhas no futuro.
À minha mulher, Fernanda.

**AGRADECIMENTOS**

A José Horácio Aboudib – meu professor em aspectos diversos que vão muito além da Cirurgia Plástica, incentivador constante e, sobretudo, amigo.

A Ruy Garcia Marques – pela orientação e oportunidade do ingresso no curso de doutorado.

À Fátima Aparecida Magalhães Costa – técnica da tomografia, incansável na realização do grande número de exames.

Aos funcionários do laboratório de pesquisa neuromuscular do INTO – por toda dedicação na realização do teste isocinético.

Aos funcionários do serviço de radiologia e informática do Hospital Quinta D'Or – pelo apoio na transferência dos exames de tomografia e resolução dos muitos problemas envolvidos nessa etapa.

Os caminhos que conduzem o homem ao conhecimento
são tão maravilhosos quanto o próprio conhecimento.
*Johannes Kepler*

# RESUMO

GUIMARÃES, Fernando Serra. **Avaliação volumétrica e funcional do músculo glúteo máximo submetido a gluteoplastia de aumento com implantes de silicone.** 2014. 131 f. Tese (Doutorado em Fisiopatologia e Ciências Cirúrgicas) – Faculdade de Ciências Médicas, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2014.

A operação para aumento de glúteos com implantes teve início no fim da década de 1960, entretanto a técnica intramuscular, considerada padrão atualmente, foi descrita cerca de 30 anos depois. Cirurgiões e pacientes apresentam crescente interesse na realização do aumento de glúteos haja vista que sua frequência apresenta aumento nos últimos anos. A utilização de implantes intramusculares que superam o volume do músculo em mais de cinquenta por cento configura uma situação nova que deve ser estudada. O tecido muscular estriado esquelético apresenta grande suscetibilidade para atrofia secundariamente à compressão, e sendo o glúteo máximo um músculo importante na manutenção da postura ereta, deambulação, corrida e salto, é necessário pesquisar possíveis alterações musculares decorrentes da operação. O objetivo deste estudo é avaliar o volume e força do músculo glúteo máximo ao longo de 12 meses após a introdução de implantes intramusculares, o posicionamento destes implantes no interior da musculatura e mudanças antropométricas obtidas com a operação. Foram selecionadas 48 mulheres, 24 candidatas a gluteoplastia de aumento com implantes compuseram o grupo de estudo e 24 candidatas a mamoplastia de aumento compuseram o grupo controle de acordo com os critérios de inclusão e exclusão. As pacientes foram avaliadas em quatro momentos diferentes: pré-operatório e após três, seis e 12 meses da operação. Em todas as etapas foi realizada avaliação clínica nutricional, tomografia computadorizada com reconstrução 3D e teste isocinético. Todas as pacientes permaneceram afastadas de atividades físicas durante três meses após a operação. Foram utilizados implantes glúteos em gel coesivo de base oval e superfície lisa com volumes de 350 $cm^3$ e 400 $cm^3$. O nível de significância estatística foi mantido em 5%. As pacientes candidatas a gluteoplastia apresentaram valores da relação entre as medidas da cintura e do quadril maiores que aquelas do grupo controle. A operação de aumento glúteo com implantes demonstrou eficácia na melhora desta relação. Os implantes apresentaram posição obliqua com inclinação semelhante à das fibras musculares após três meses da operação, independente da posição em que foram inseridos. As pacientes do grupo de estudo apresentaram atrofia muscular após 12 meses em 6,14% à esquerda e 6,43% à direita, as pacientes do grupo controle não apresentaram atrofia. A força muscular apresentou redução do valor de torque máximo durante a flexão do quadril a 30 °/s em ambos os grupos e aumento do torque máximo durante a adução a 60 °/s apenas no grupo de estudo. Concluímos que a introdução de implante de silicone no interior do músculo glúteo máximo causa atrofia muscular após 12 meses. As variações na força deste músculo nesse período não podem ser atribuídas primariamente à operação ou à presença dos implantes em seu interior. Os implantes permaneceram em posição obliqua. O aumento de glúteos com implantes gera mudanças antropométricas nas mulheres submetidas a esta operação.

Palavras-chave: Prótese. Glúteo. Gluteoplastia de aumento. Dinamometria isocinética.

# ABSTRACT

GUIMARÃES, Fernando Serra. **Volumetric and functional evaluation of the gluteus maximus muscle after augmentation gluteoplasty using silicone implants.** 2014. 131 f. Tese (Doutorado em Fisiopatologia e Ciências Cirúrgicas) – Faculdade de Ciências Médicas, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2014.

The gluteal augmentation surgery using implants began in the late 1960s, however intramuscular technique, which is considered standard today, was described about 30 years later. Plastic surgeons and patients have increased interest in gluteal augmentation given the fact that the operation has been more frequently in recent years. The use of intramuscular implants that overcomes the muscle volume in more than fifty percent configures a new situation that should be studied. The skeletal muscle tissue shows high susceptibility to atrophy secondary to compression, and the gluteus maximus is an important muscle in the maintenance of erect posture, walking, running and jumping, it is necessary to investigate possible muscle changes resulting from the operation. The objective of this study is to assess the volume and strength of the gluteus maximus muscle during 12 months after the introduction of the implants, the position of these implants within the muscles and anthropometric changes obtained with the operation. 48 women were selected, 24 candidates for gluteal augmentation composed the study group and 24 candidates for breast augmentation composed the control group according to the criteria of inclusion and exclusion. The patients were evaluated at four different moments: pre-operatively and after three, six and 12 months of the operation. At all stages of the study, was carried out nutritional evaluation, CT with 3D reconstruction and isokinetic testing. All patients remained away from physical activities for three months after the operation. Cohesive gel, oval base and smooth surface gluteal implants were used with volumes of 350 $cm^3$ and 400 $cm^3$. The level of statistical significance was 5%. The patients who were candidates for gluteoplasty presented bigger waist to hip ratio than those of the control group. The operation of gluteal augmentation using implants has shown to be effective in improving this ratio. The implants showed similar oblique position of the muscle fibers after three months of operation, regardless of the position in which they were placed. The patients in the study group had muscle atrophy after 12 months, 6.14% 6.43% left and right, the control patients showed no atrophy. Muscle strength decreased the maximum torque during hip flexion at 30 °/s in both groups and increased maximum torque during the adduction at 60 °/s only in the study group. We conclude that the introduction of silicone implant within the gluteus maximus muscle causes muscle atrophy after 12 months. Variations in the strength of this muscle during this period cannot be attributed primarily to the operation or the presence of implants. The implants remained in oblique position. The gluteal augmentation surgery generates anthropometric changes in women who have undergone this operation.

Keywords: Prosthesis. Gluteus. Augmentation gluteoplasty. Isokinetic dynamometry.

**LISTA DE FIGURAS**

**LISTA DE GRÁFICOS**

**LISTA DE TABELAS**

## LISTA DE ABREVIATURAS E SIGLAS

| | |
|---|---|
| a.C. | Antes de Cristo |
| CONEP | Conselho Nacional de Ética em Pesquisa |
| d.C. | Depois de Cristo |
| DIf Vol | Variável diferença de volume |
| Dif Iso | Variável diferença de força |
| DIR | Direito |
| ESQ | Esquerdo |
| TC | Tomografia Computadorizada |
| HUPE | Hospital Universitário Pedro Ernesto |
| IMC | Índice de massa corporal |
| INTO | Instituto Nacional de Traumatologia e Ortopedia |
| RCQ | Relação entre as medidas da cintura e do quadril |
| Uerj | Universidade do Estado do Rio de Janeiro |

**LISTA DE SÍMBOLOS**

| | |
|---|---|
| $Kg/m^2$ | Quilograma por metro quadrado |
| ® | Marca registrada |
| $g/mm^2$ | Grama por milímetro quadrado |
| 3D | Três Dimensões |
| º/s | Graus por segundo |
| N m | Newton metro |
| J/min | Joules por minuto |
| W | Watt |

**SUMÁRIO**

# INTRODUÇÃO

Desde a evolução da espécie humana, a musculatura glútea apresenta grande importância. Dentre as alterações anatômicas necessárias para a adoção da postura bípede, o desenvolvimento do grupamento muscular glúteo foi crucial para manter a postura ereta e estabilizar a pelve.[1] Entretanto, a valorização desta região anatômica do ponto de vista estético tem seus primeiros registros com a Vênus de Milo (Séc. IV-II a.C.) e com a Aphrodite de Calipígia (200 a.C.).[2] Atualmente, a região glútea apresenta grande importância estética representada pelo interesse crescente da população na realização de gluteoplastias.[3]

O procedimento cirúrgico para aumento da região glútea com a utilização de implantes ocorreu pela primeira vez em 1969, com a utilização de implante de mama para o tratamento de uma paciente com atrofia glútea idiopática.[4] Durante a década de setenta, esta operação foi utilizada com finalidade estética.[5] O mexicano Dr Gonzáles Ulloa foi o responsável pelo estudo antropométrico da região e desenvolvimento de implantes específicos para os glúteos, capazes de resistir às forças de compressão locais, assim como permitir o aumento natural da região.[6] Inicialmente, utilizou o plano de dissecção subcutâneo para introdução dos implantes, apresentando diversas desvantagens, como contratura capsular e ptose glútea, devido à ausência de sustentação pela tela subcutânea e pele.[2,7] Em 1984, foi descrita a técnica submuscular, com o propósito de evitar tais complicações,[8] entretanto a proximidade com o nervo isquiático aumentava as chances de neuropatia compressiva e a necessidade de manter os implantes em posição cranial em relação a este nervo comprometia, sobremaneira, a naturalidade dos resultados.[9] Finalmente, em 1996, surgia no México a técnica intramuscular para o aumento das nádegas com implantes.[10] (Figura 1) Nesta técnica, o implante é envolto pelo músculo glúteo máximo em toda sua superfície, fazendo com que não seja visível ou palpável. Ao longo dos últimos 15 anos, esta técnica se popularizou e foi aperfeiçoada,[3,11] melhorando os resultados e diminuindo os índices de complicações pós-operatórias.[12-14] Em 2004, foi descrita a técnica subfascial, na qual os implantes são posicionados abaixo da fáscia do músculo glúteo máximo porém acima de suas fibras.[15] A fáscia muscular é uma estrutura anatômica delgada fazendo com que os implantes nesta localização apresentem evolução semelhante à técnica subcutânea, com maior incidência de complicações quando comparado com a técnica intramuscular.[16,17]

Figura 1 – Planos anatômicos de inserção do implante glúteo

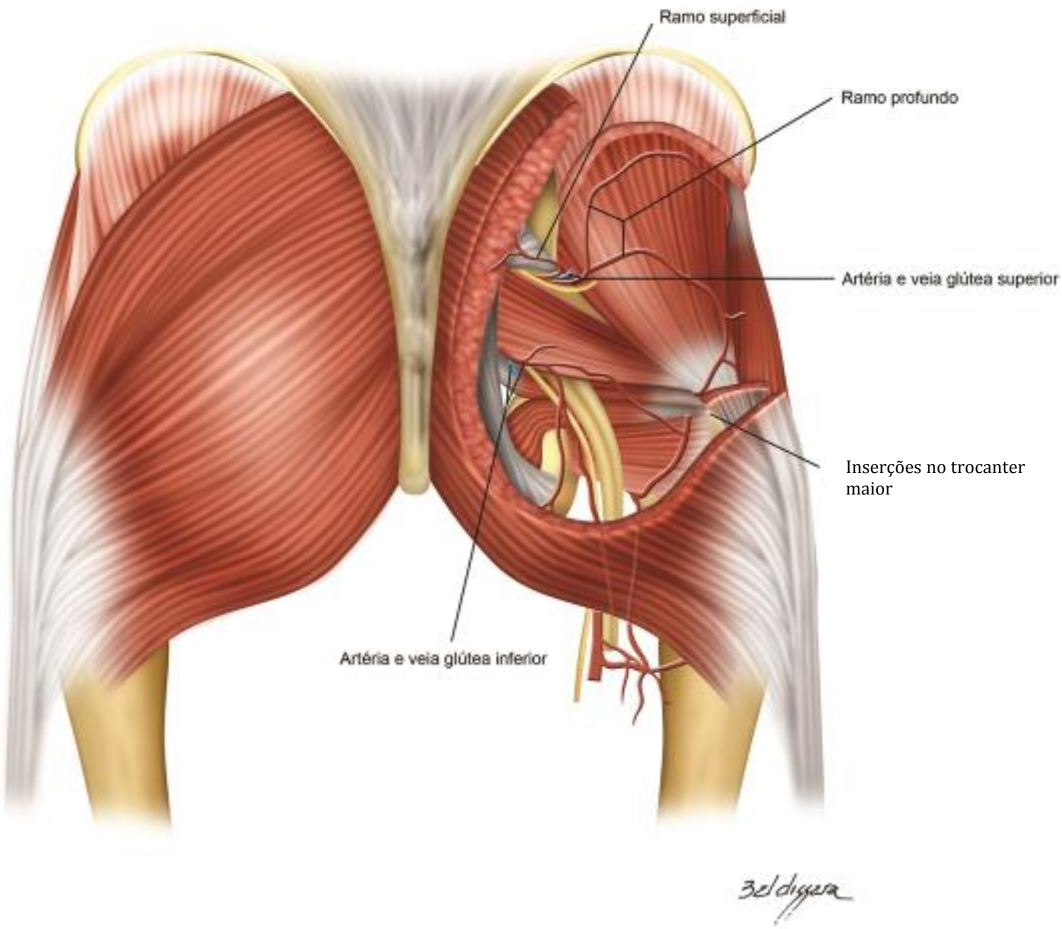

Legenda: de acordo com os autores de cada técnica.

O músculo glúteo máximo é o principal responsável pelo contorno da região glútea e pela anatomia de superfície dessa região [18] e o procedimento cirúrgico para o aumento do volume das nádegas está entre os procedimentos com maior crescimento atualmente.[19] Diversas técnicas podem ser utilizadas com esta finalidade, como enxerto de gordura, implantes, retalhos locais ou combinando duas ou mais técnicas.[3,20,21] A maior previsibilidade dos resultados, em virtude da menor variação no volume final, faz com que os implantes alcancem resultados nem sempre conseguidos com os enxertos.[22]

O conhecimento detalhado da anatomia do músculo glúteo máximo é fundamental para a dissecção em seu interior e para a introdução dos implantes.

O glúteo máximo é o músculo mais espesso do corpo humano, variando entre 4 e 6 cm em sua porção central. Origina-se na crista ilíaca, íleo, sacro, cóccix e ligamento sacro tuberal, com inserções na tuberosidade glútea e linha áspera do corpo do fêmur, e no trato iliotibial da fáscia lata. É um músculo extensor da coxa, estabiliza a pelve durante a deambulação e atua em movimentos, como levantar de posição sentada, correr e saltar.[7,9,18] A vascularização é proveniente das artérias glúteas superior e inferior, que emergem acima e abaixo do músculo piriforme, respectivamente, e se ramificam no interior do músculo, caracterizando padrão vascular tipo III de Mathes e Nahai.[23] É inervado pelo nervo glúteo inferior, que penetra na superfície profunda do musculo glúteo máximo, após emergir da pelve abaixo do músculo piriforme. No interior da musculatura, esse nervo se ramifica, sendo que ramos mais espessos que 0,3 mm mantêm seu trajeto abaixo de 60% da espessura muscular em profundidade.[24] (Figura 2)

Figura 2 – Anatomia glútea




Legenda: Abaixo do músculo glúteo máximo.

O músculo piriforme origina-se no sacro e no ligamento sacrotuberal, inserindo-se na borda superior do trocanter maior do fêmur.[25,26] Possui grande importância, por dividir o forame isquiático maior, dando passagem ao nervo isquiático,[7,18] maior nervo do corpo humano, formado pelos nervos tibial e fibular comum, que emerge da pelve abaixo deste músculo. Variações anatômicas são encontradas em 15% a 30% dos casos.[27] O nervo isquiático consiste em uma estrutura de fundamental importância, pois pode ser alvo de complicações secundárias a compressão pelo implante ou irritação nervosa por coleção sanguínea decorrente do procedimento cirúrgico.

# 1 JUSTIFICATIVA

Desde a descrição da técnica intramuscular para gluteoplastia de aumento,[10] o uso de implantes intramusculares era limitado ao tratamento de doenças neuromusculares e cirurgia experimental, com utilização de implantes de pequeno volume.[28,29] Pacientes submetidos a gluteoplastia intramuscular possuem uma situação inédita do ponto de vista fisiológico, em que o músculo glúteo máximo possui em seu interior um implante com cerca de metade do volume da massa muscular. Alguns estudos publicados comparam as técnicas de gluteoplastias, avaliando, sobretudo, os resultados pós-operatórios,[7,13,30] embora as publicações relacionadas a complicações não avaliam o comportamento da musculatura ou o posicionamento dos implantes após a operação.[14,31]

Os músculos estriados esqueléticos apresentam grande suscetibilidade para atrofia e lesão por apoptose secundariamente à compressão externa, conforme demonstrado nos estudos das ulceras de pressão em modelos experimentais e série de casos.[32-35] A introdução de implantes glúteos no interior da musculatura pode ser um fator de compressão intrínseco desse músculo, assim como atuar em sinergismo com fatores compressivos externos. A dissecção intramuscular divide o músculo em dois retalhos, superficial e profundo, podendo comprometer a sua capacidade contrátil. A operação para aumento dos glúteos com implantes produz portanto, mudanças no músculo glúteo máximo potencialmente capazes de comprometer seu funcionamento como unidade contrátil e potente extensor da coxa. Até o presente momento o comportamento anatômico e funcional do músculo não foi avaliado. É de fundamental importância que saibamos como evolui o grupamento muscular glúteo após a introdução de implantes, para definição da segurança deste procedimento cirúrgico e estabelecimento dos limites de volume dos implantes utilizados.

# 2 OBJETIVOS

## 2.1 Primário

Avaliar o volume do músculo glúteo máximo e sua variação ao longo de 12 meses, após a introdução de implantes.

Avaliar a força muscular do grupamento glúteo e correlacionar esta com o volume do músculo glúteo máximo durante o mesmo período

## 2.2 Secundário

Avaliar o posicionamento dos implantes de silicone de base oval e sua estabilidade no interior da musculatura glútea.

Avaliação antropométrica das pacientes candidatas a operação e suas mudanças após a gluteoplastia com implantes.

# 3 MÉTODO

## 3.1 Aspectos éticos

Este é um estudo clinico, prospectivo, controlado e foi aprovado pelo Conselho Nacional de Ética em Pesquisa (Conep), sob o número 0011.0.305.305-10. Todos os sujeitos da pesquisa participaram voluntariamente, receberam informações quanto aos objetivos e métodos empregados na pesquisa, assim como possíveis riscos inerentes ao exame de tomografia computadorizada, ao ato operatório e ao teste isocinético, e assinaram o termo de consentimento livre e esclarecido (Apêndice A).

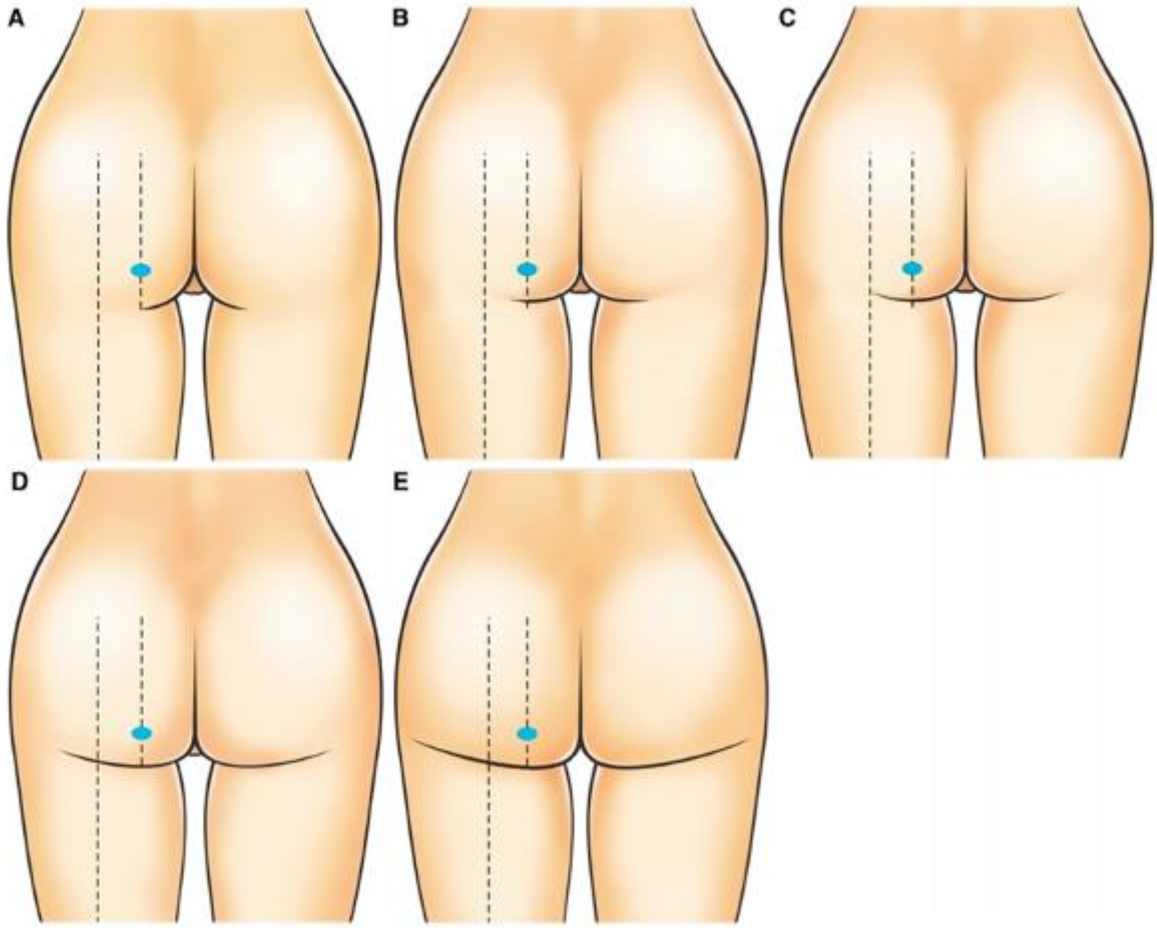
## 3.2 Amostra

Os sujeitos da pesquisa são provenientes do ambulatório de Cirurgia Plástica do Hospital Universitário Pedro Ernesto (HUPE), da Universidade do Estado do Rio de Janeiro (UERJ), selecionados consecutivamente entre Janeiro e Junho da 2010, tanto para compor o grupo de estudo quanto o grupo controle. Todos são do sexo feminino, com idade variando entre 19 e 50 anos, com características antropométricas e índice de massa corporal (IMC) dentro de limites pré-estabelecidos, com o objetivo de criar grupos semelhantes.

**Critérios de inclusão** – IMC entre 17 e 28 Kg/m$^2$, ptose glútea graus 0, I, II ou III e relações antropométricas tipos II, III e IV.[36,37] (Figuras 3 e 4)

**Critérios de exclusão** – Doenças crônicas, artropatias, gestantes (independentemente do período em que foi diagnosticada a gestação), necessidade de terapia antiretroviral ou com corticosteróides, acidentes envolvendo a região glútea, infecções crônicas fora do sítio operatório, claustrofobia grave conhecida e variações significativas no IMC durante o período estudado.

Figura 3 – Classificação de ptose glútea.



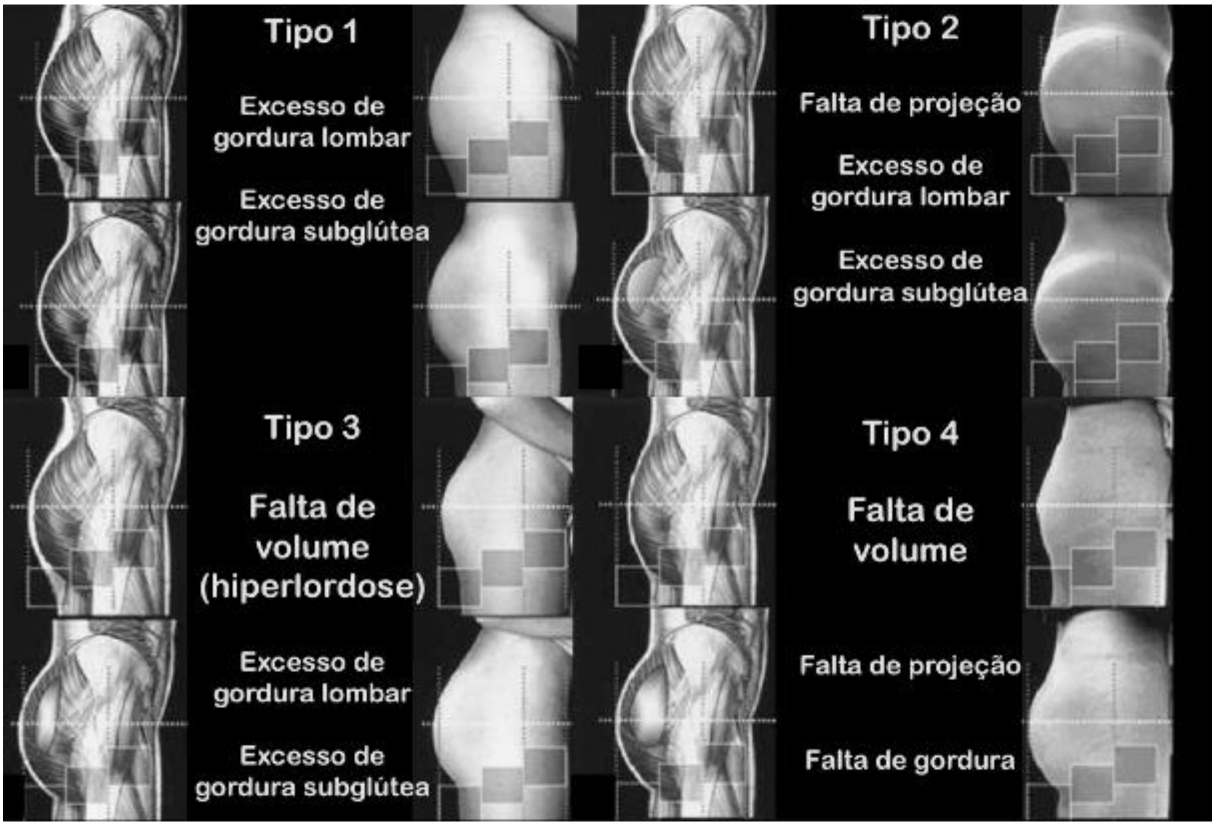

Legenda: A – grau zero: o sulco infraglúteo não ultrapassa a linha que passa pelo tubérculo isquiático(T); B – grau 1: o sulco infra glúteo ultrapassa a linha T; C – grau 2: o sulco infra glúteo alcança a linha média da coxa(M); D – grau 3: o sulco infra glúteo ultrapassa a linha M; E – grau 4: presença de tecido com ptose na linha M.

Fonte: Gonzalez R. Etiology, definition, and classification of gluteal ptosis. Aesthetic Plast Surg. May-Jun 2006;30(3):320-326.

**Grupo de estudo –** Selecionadas 24 mulheres candidatas a gluteoplastia de aumento com implantes, de acordo com os critérios de inclusão e exclusão.

**Grupo controle –** Selecionadas 24 mulheres candidatas a mamoplastia de aumento, de acordo com os critérios de inclusão e exclusão.

Figura 4 – Classificação antropométrica das nádegas




Fonte: Cuenca-Guerra R, Quezada J. What makes buttocks beautiful? A review and classification of the determinants of gluteal beauty and the surgical techniques to achieve them. Aesthetic Plast Surg. Sep-Oct 2004;28(5):340-347.

**Todas as pacientes (grupo de estudo e grupo controle)** – permaneceram afastadas de atividades físicas durante os primeiros três meses após a operação para plena recuperação.

As avaliações foram realizadas em quatro momentos da pesquisa: pré-operatório, e após três, seis e 12 meses do ato operatório. Em cada etapa, foi realizado teste isocinético, tomografia computadorizada de glúteos e avaliação clínica nutricional.

### 3.3 **Avaliação clínica nutricional**

Em cada etapa da pesquisa, a avaliação nutricional foi realizada por profissional nutricionista, aferindo as seguintes variáveis:

3.3.1 Massa

Aferida em balança antropométrica manual Filizola®, com divisões de 100 g e carga máxima de 150 Kg. As pacientes foram avaliadas sem calçados, usando apenas roupas íntimas. Unidade – quilograma (Kg).

3.3.2 Altura

Aferida com estadiômetro fixo a uma parede sem rodapé, com extensão de 2 m e esquadro acoplado em sua extremidade, segundo as normas preconizadas por Jellife[38]. Unidade – metros (m).

3.3.3 Índice de massa corporal

Obtido com a aplicação da fórmula:
Unidade – $Kg/m^2$.

$$\frac{\text{MASSA}}{\text{ALTURA}^2}$$

3.3.4 Circunferência da cintura

Aferida com fita flexível e inelástica ao redor da cintura no ponto de menor medida situado entre as costelas e a crista ilíaca, mantendo a fita justa, sem comprimir os tecidos. Unidade – centímetros (cm).

3.3.5 Circunferência do quadril

Aferida com fita flexível e inelástica ao redor do quadril próximo ao púbis no ponto de maior medida, mantendo a fita justa, sem comprimir os tecidos. Unidade – centímetros (cm).

3.3.6 Percentual de gordura corporal

Aferido com adipômetro Lange®, escada 0-60 mm, precisão de 1 mm e pressão da mola constante de 10 $g/mm^2$.

### 3.3.7 Padrão de distribuição da gordura corporal

Definida através da comparação entre a gordura androide e ginoide.[39]

A proporção de gordura androide foi definida como:

Gordura no tronco + gordura nos braços / total de gordura corporal.

A proporção de gordura ginoide foi definida como:

Gordura nas pernas e quadril / total de gordura corporal.

## 3.4 **Tomografia computadorizada**

Os exames de tomografia computadorizada (TC) foram realizados no Setor de Radiologia do Hospital Universitário Pedro Ernesto, em tomógrafo G.E. *Hi speed*® (*General Eletric, Milwaukee,* WI-USA, 1999), com aquisição helicoidal e cortes de 3 mm.

A reconstrução em três dimensões (3D) e volumetria muscular foram realizados no Serviço de Radiologia do Hospital Quinta D'Or. Foi utilizado para esta interpretação o *software Extended brilliance workspace* (V3.5.0 2250, 12-Apr-2007, Philips Medical Systems – Netherland), que permite o isolamento do músculo por meio da diferença de densidade dos tecidos. (Figura 5)

Foi criada a variável diferença de volume (Dif vol) mediante a subtração do volume do músculo glúteo máximo obtido com três, seis ou 12 meses do valor do volume muscular pré-operatório para os lados direito e esquerdo.

Exemplo:

Dif vol Dir 3 meses= volume muscular direito de três meses – volume muscular direito pré-operatório.

Esta variável foi utilizada na comparação da evolução do músculo glúteo máximo entre os grupos.

O exame de tomografia computadorizada foi realizado em todos os sujeitos da pesquisa. Concomitantemente, foi realizada análise prospectiva de uma série de casos composta de 23 pacientes, utilizando a mesma metodologia para a realização da TC, com o objetivo de inquirir o posicionamento dos implantes. Nesta série de casos, foram utilizados implantes redondos em nove pacientes e implantes ovais em 14 pacientes. Dentre estes, foram utilizadas diferentes inclinações no plano coronal, em função da indicação clínica.

## 3.5 **Teste isocinético**

A avaliação da força muscular foi realizada no Laboratório de Pesquisa Neuromuscular do Instituto Nacional de Traumatologia e Ortopedia (INTO), com a utilização do dinamômetro isocinético CSMI, modelo Humac Norm®(Stoughton, MA – USA – 2008), para aplicação do teste de dinamometria isocinética, durante a flexão/extensão e adução/abdução do quadril.

Todas as pacientes não realizaram treinamento sistemático da força muscular nas ultimas quatro semanas que antecederam ao inicio da pesquisa.

Para o estudo da força de flexão/extensão, as pacientes foram avaliadas em posição supina. O eixo do quadril é alinhado com o centro do braço de alavanca do dinamômetro. A pelve é estabilizada com cinto e com a ajuda do pesquisador assistente até o limite de flexão/extensão do quadril. Neste teste, o quadril passa da amplitude final de flexão até a amplitude final de extensão, finalizando o ciclo na flexão máxima.

No teste de força muscular no dinamômetro para adução/abdução de quadril, o paciente é posicionado em decúbito lateral, com o eixo articular alinhado com o centro do braço de alavanca do dinamômetro. Os limites da amplitude de movimento são estabelecidos no ponto em que um movimento extra produz inclinação pélvica lateral. Neste teste, o quadril passa da amplitude final de adução até abdução final, concluindo o ciclo na adução máxima. O joelho deverá ser mantido em flexão de repouso e o quadril em rotação neutra, dentro dos limites de alinhamento ósseo do sujeito.

Foram utilizadas as velocidades de 30 °/s e 60 °/s. As pacientes realizaram teste de familiarização e, a partir daí, realizaram cinco repetições máximas, sendo registrado o índice de melhor performance para cada velocidade. As medidas de torque máximo foram coletadas no lado dominante, mediante a informação de qual lado seria usado para chutar uma bola com o objetivo de acertar uma área na parede.[40]

Foi criada a variável diferença de força (Dif iso), por meio da subtração do valor de torque máximo obtido com três, seis ou 12 meses, do valor de torque máximo pré-operatório para o lado dominante.

Exemplo:

Dif iso30 adu 3 meses= Torque máximo de adução a 30 $^{o}$/s de três meses – Torque máximo de adução a 30$^{o}$/s pré-operatório.

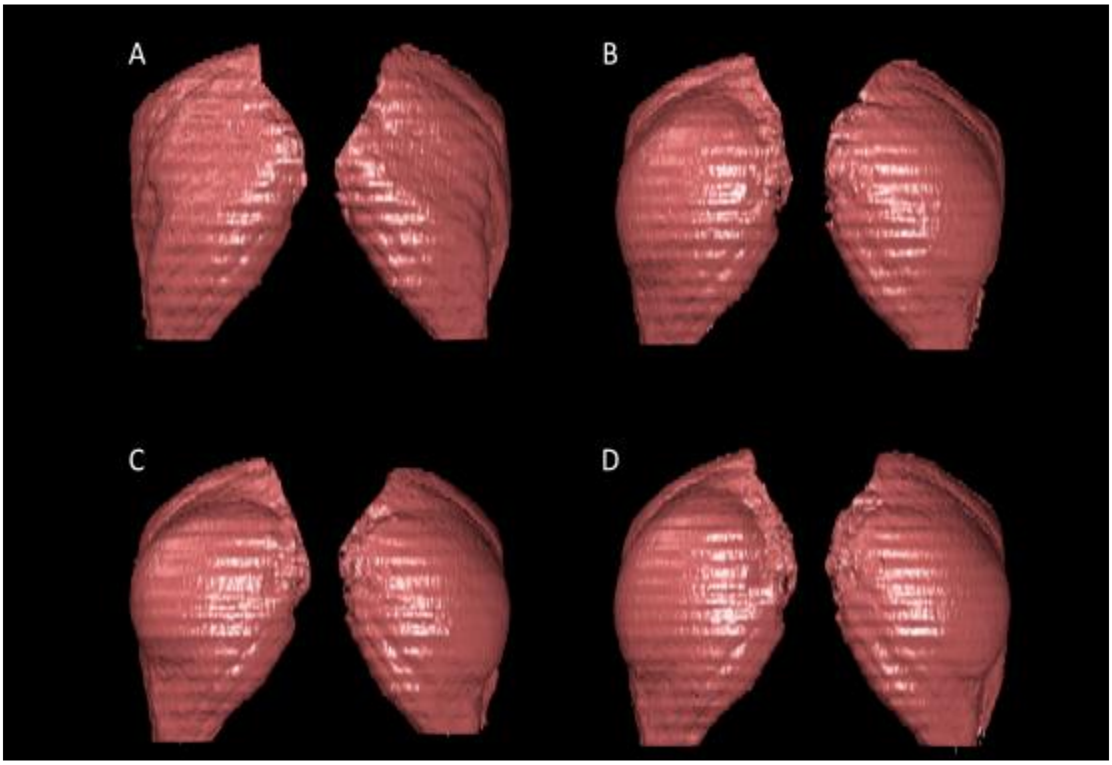
Esta variável foi utilizada na comparação da evolução da força do músculo glúteo máximo entre os grupos de estudo e controle.

## 3.6 **Técnica cirúrgica**

Os pacientes do grupo de estudo foram submetidos a gluteoplastia de aumento com a técnica intramuscular. A incisão em forma de elipse posicionada no sulco interglúteo, com 6 cm de comprimento e 5 mm de largura, tem a epiderme removida com preservação da derme. A dissecção subcutânea em direção à fáscia muscular, com inclinação de 45 graus, bilateralmente, preserva uma ilha de tecido celular subcutâneo e derme que contém o ligamento sacro cutâneo.[11] (Figura 6)

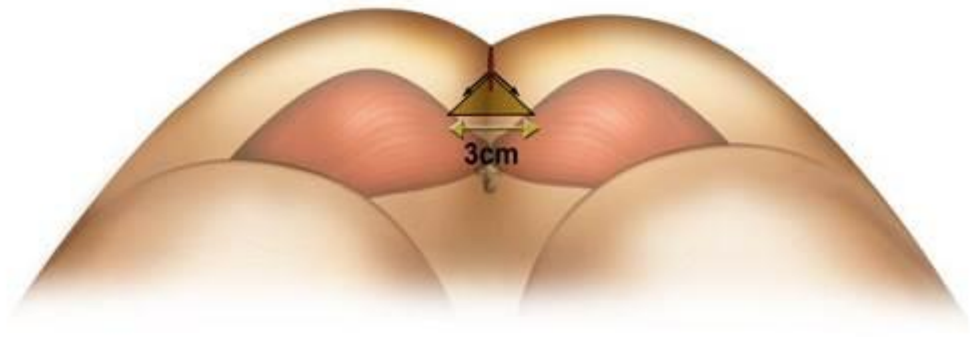
A dissecção muscular é realizada com duas espátulas rombas, diminuindo a lesão muscular. (Figura 7) Um dos dissectores utilizados foi desenvolvido pelo autor e realizado depósito de pedido de patente conforme o anexo A. O implante glúteo é introduzido no interior do músculo glúteo máximo, em profundidade que varia entre 2-2,5 cm.[41] (Figura 8) Esta dissecção intramuscular deve ser maior que a base dos implantes em 2 a 3 cm, para que a síntese do músculo seja livre de tensão, tendo como limites a espinha ilíaca posterosuperior e crista ilíaca superiormente, o trato iliotibilal lateralmente, o sulco infraglúteo inferiormente e o osso sacro medialmente.[3]

Figura 5 – Tomografia computadorizada com reconstrução glútea 3D




Legenda: A – pré-operatório; B, C e D – após três, seis e 12 meses de introdução de implantes glúteos, respectivamente.

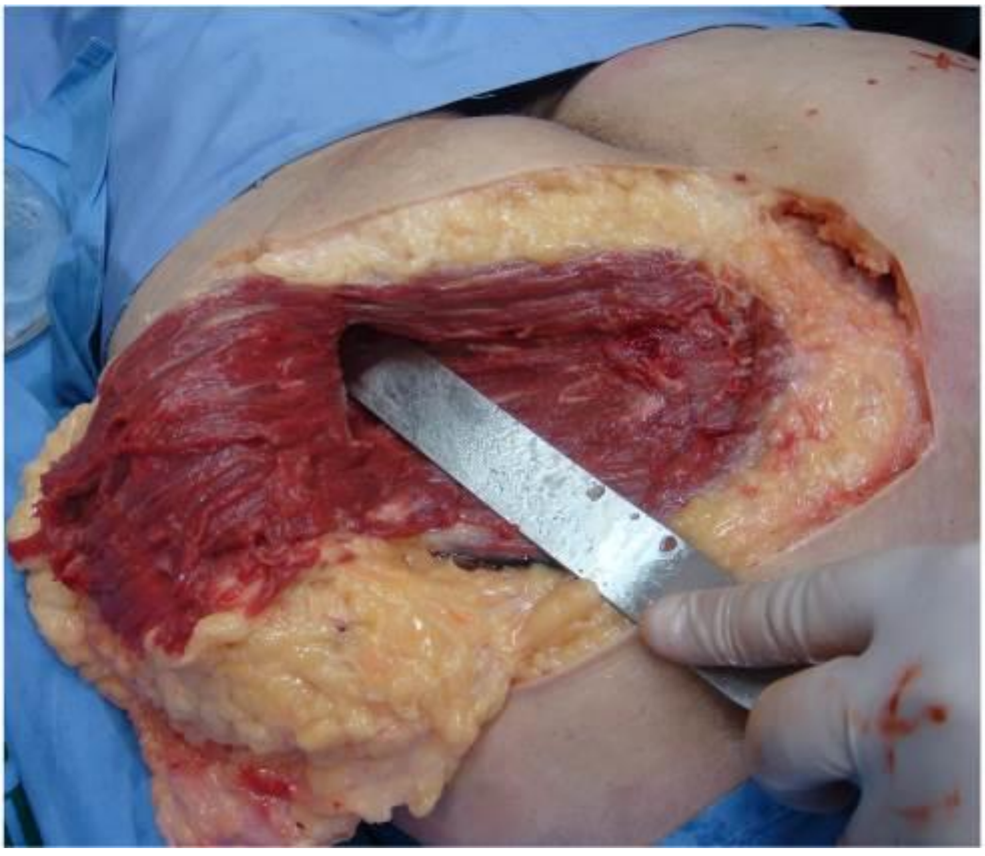
Figura 6 – Incisão cutânea e dissecção subcutânea




Fonte: Serra F, Aboudib JH, Marques RG. Reducing wound complicatons in gluteal augmentation surgery. Plast Reconstr Surg. 2012;130(5):706e-713e.

Figura 7 – Instrumental não cortante utilizado para dissecção intramuscular.


Figura 8 – Dissecção de cadáver



Legenda: Profundidade do plano intramuscular, entre 2-2,5 cm.

Foram utilizados implantes glúteos em gel coesivo, de base oval (Silimed®) e superfície lisa com volumes de 350 $cm^3$ e 400 $cm^3$ (média= 356,8 $cm^3$, mediana=350 $cm^3$).

## 3.7 **Análise estatística**

Foi elaborada a análise estatística descritiva para a totalidade da amostra, estabelecendo-se a média como medida de tendência central e o desvio padrão como medida de dispersão.

Os dados foram analisados quanto ao modo de distribuição por meio do teste de Shapiro-Wilk. Os dados de distribuição normal foram analisados com a utilização do teste t de student e os dados de distribuição não gaussiana foram analisados por testes não paramétricos, teste de Wilcoxon para dados pareados e Mann-Whitney para dados não pareados.

O nível de significância estatística foi mantido em 5%. As análises foram realizadas no *Software* R, versão 3.0.2.

# 4 **RESULTADOS**

Todas as pacientes selecionadas de acordo com os critérios pré-estabelecidos foram operadas, sendo 24 pacientes compondo o grupo de estudo submetidas a procedimento cirúrgico para introdução de implantes glúteos e 24 pacientes compondo o grupo controle, submetidas a mamoplastia de aumento. Quatro pacientes foram excluídas do estudo durante o seguimento pós-operatório, sendo duas do grupo de estudo e duas do grupo controle. Os motivos foram abandono no seguimento (duas pacientes), gestação (uma paciente) e hérnia de disco em coluna lombar (uma paciente).

A tabela 1 apresenta análise comparativa entre os grupos de estudo e controle em relação a idade e a avaliação nutricional.

A relação entre as medidas da circunferência da cintura e do quadril (RCQ) foram comparadas entre os indivíduos do mesmo grupo e entre os grupos, antes e após a operação, conforme o gráfico 1.

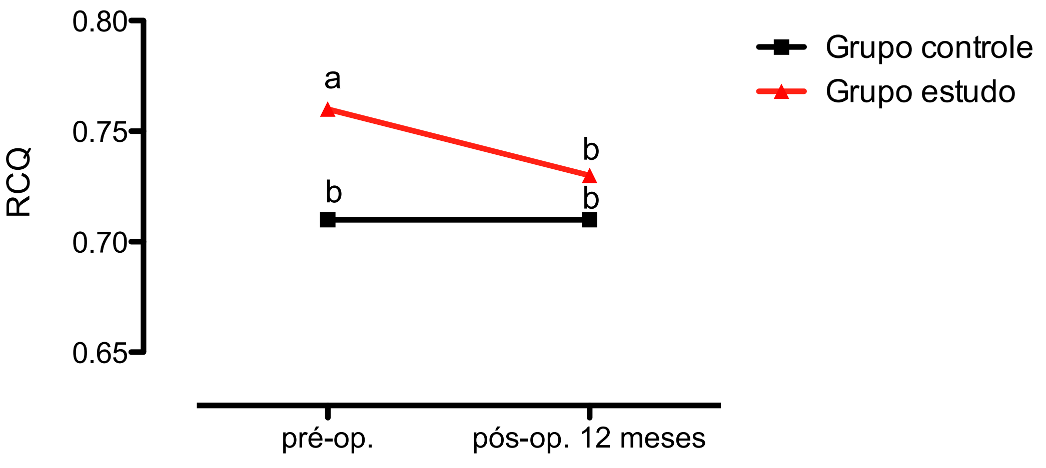
Tabela 1 – Avaliação clínica pré-operatória

| | **Idade (anos*)** | **IMC (Kg/m$^2$)*** | **Circunferência do quadril (cm)*** | **Relação cintura / quadril*** | **Percentual de gordura*** |
|---|---|---|---|---|---|
| **Grupo de estudo (n=22)** | 32,9 (22-46) | 22,2 (17,9-27,3) | 94,8 (86-107) | 0,76 (0,68-0,85) | 23,6 (16-32,2) |
| **Grupo controle (n=22)** | 27,9 (19-50) | 21,8 (18,6-25) | 96,4 (87,5-107) | 0,71 (0,61-0,8) | 24,8 (18,6-36,3) |
| **Valor de *p*** | 0,01 | 0,54 | 0,33 | 0,0002 | 0,4 |

*Valores apresentados como Média (mínimo-máximo)

O padrão de distribuição da gordura corporal foi classificado como androide em seis pacientes do grupo de estudo. Todas as demais, de ambos os grupos, foram classificados como padrão ginoide. Após a operação, as seis pacientes de padrão androide mudaram sua classificação para ginoide, sendo que as demais permaneceram com este padrão de distribuição gordurosa. Não houve variações estatisticamente significativas no IMC das pacientes ao longo do período estudado.

Gráfico 1 – A relação entre as medidas da circunferência da cintura e do quadril

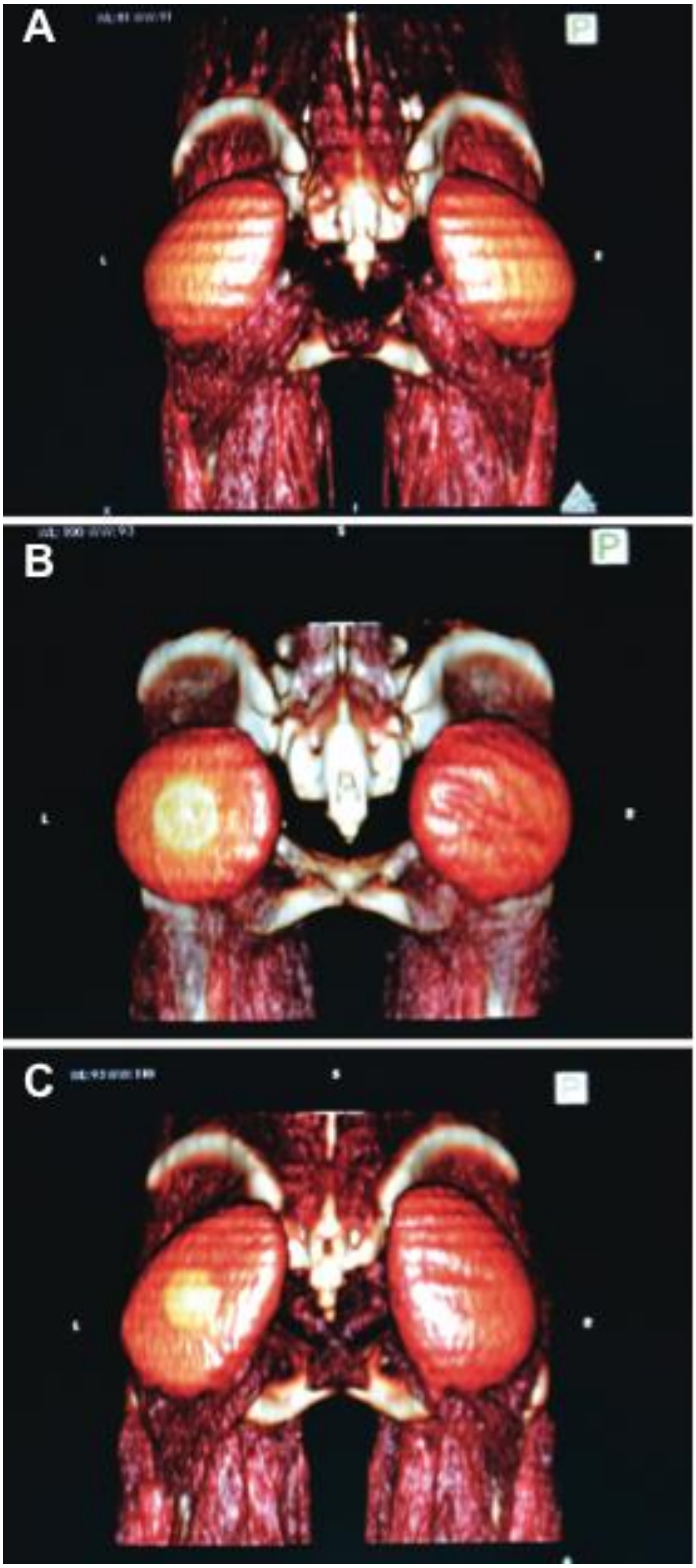



Legenda; Letras diferentes correspondem a significância estatística na comparação entre as médias ($p$<0,05).

A avaliação do posicionamento dos implantes por tomografia computadorizada na série de casos de 23 pacientes (46 glúteos) revelou que, após três meses da operação, todos os implantes ovais (28/46) assumiram posição oblíqua, com inclinação semelhante à das fibras musculares, independentemente do posicionamento no momento de sua introdução. Em dois casos (2/46), em um implante redondo e outro oval, foi diagnosticado inversão anteroposterior da posição dos implantes. (Figura 9)

O exame de tomografia computadorizada com reconstrução volumétrica em 3D forneceu os dados de volume do músculo glúteo máximo. O grupo de estudo apresentou atrofia muscular em 6,14% à esquerda e 6,43% à direita, após 12 meses da operação, em relação ao volume pré-operatório. A análise comparativa entre os grupos, assim como a evolução de cada grupo individualmente, está representada no gráfico 2.

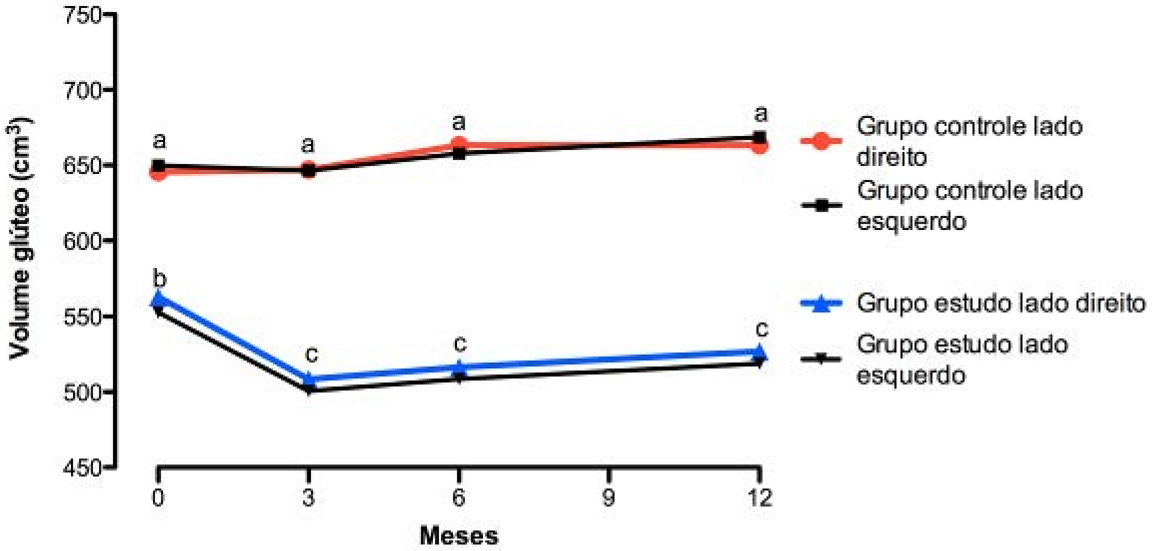
Figura 9 – Posição dos implantes




Legenda: A: Implante oval, 300 $cm^3$, 12 meses de pós-operatório, introduzido em posição vertical. B e C: Inversão anteroposterior da posição dos implantes redondo e oval, respectivamente.

Fonte: Serra F, Aboudib JH, Marques RG. Intramuscular technique for gluteal augmentation: determination and quantification of muscle atrophy and implant position by computed tomographic scan. Plastic and reconstructive surgery. Feb 2013;131(2):253e-259e

Gráfico 2 – Volumetria do músculo glúteo máximo




Legenda: Letras diferentes correspondem a significância estatística na comparação entre as médias ($p$<0,05). Grupo controle n=20, grupo estudo n=22.

A variável diferença de volume (Dif vol) foi utilizada na comparação da evolução do músculo glúteo máximo entre os grupos, demonstrando diferença em todos os momentos da pesquisa. (Tabela 2)

O teste de dinamometria isocinética forneceu os dados da força muscular em diferentes velocidades angulares, 30 °/s e 60 °/s. A evolução da força muscular ao longo dos 12 meses demonstrou diferenças na flexão do quadril quando comparada com seus valores pré-operatórios em ambos os grupos analisados separadamente para velocidade de 30 °/s. Os demais movimentos testados não apresentaram alterações. (Tabela 3) A mesma análise no teste isocinético a 60 °/s apresentou aumento de força durante a adução, no grupo de estudo. (Tabela 4)

A variável diferença de força (Dif iso), foi utilizada na comparação da evolução da força do músculo glúteo máximo entre os grupos de estudo e controle. (Tabelas 5 e 6)

Tabela 2 – Comparação entre os grupos da variável diferença de volume

| **Variável** | **Grupo Controle*** | **Grupo Estudo*** | **Valor de *p*** |
|---|---|---|---|
| Dif vol Esq 3 meses | 0,083 | -52,1 | 0,0004 |
| Dif vol Esq 6 meses | 8,06 | -46,6 | 0,0006 |
| Dif vol Esq 12 meses | 18,9 | -33,8 | 0,0012 |
| | | | |
| Dif vol Dir 3 meses | 5,77 | -54,6 | 0,0001 |
| Dif vol Dir 6 meses | 17,2 | -48,8 | 0,0001 |
| Dif vol Dir 12 meses | 17,7 | -36,2 | 0,0022 |

*Valores apresentados como média das diferenças ($cm^3$)

A análise estatística não apresentou correlação significativa entre a variável diferença de volume e diferença de força muscular após 12 meses da operação, excetuando-se o teste isocinético de adução a 60 $^{o}$/s, em que se observou correlação moderadamente positiva no grupo de estudo. (Gráfico 3)

Tabela 3 – Teste isocinético a 30 º/s. Avaliação de cada um dos grupos, separadamente

| | Grupo de estudo | | | Grupo controle | |
|---|---|---|---|---|---|
| **Teste isocinético** | **Comparação (Nm)** | **valor de *p*** | **Teste isocinético** | **Comparação (Nm)** | **valor de *p*** |
| Adução | Pré * x 3 meses † (101,3) (104,2) | 0,94 | adução | Pré ◊x 3 meses ‡ (117,8) (119,5) | 0,67 |
| Adução | Pré x 6 meses # (101,3) (112,1) | 0,19 | adução | Pré x 6 meses ¥ (117,8) (117,8) | 0,9 |
| Adução | Pré x 12 meses Δ (101,3) (112,4) | 0,97 | adução | Pré x 12 meses ß (117,8) (118,8) | 0,18 |
| Abdução | Pré x 3 meses (59,8) (54,1) | 0,054 | abdução | Pré x 3 meses (64,6) (63,9) | 0,84 |
| Abdução | Pré x 6 meses (59,8) (56,2) | 0,14 | abdução | Pré x 6 meses (64,6) (63,8) | 0,86 |
| Abdução | Pré x 12 meses (59,8) (55,9) | 0,18 | abdução | Pré x 12 meses (64,6) (65,5) | 0,5 |
| Flexão | Pré x 3 meses (68,5) (62,7) | 0,028 | flexão | Pré x 3 meses (69,7) (66,8) | 0,26 |
| Flexão | Pré x 6 meses (68,5) (63,1) | 0,03 | flexão | Pré x 6 meses (69,7) (65,6) | 0,045 |
| Flexão | Pré x 12 meses (68,5) (62,3) | 0,006 | flexão | Pré x 12 meses (69,7) (69,0) | 0,4 |
| Extensão | Pré x 3 meses (164,4) (152,3) | 0,09 | extensão | Pré x 3 meses (177) (170,8) | 0,4 |
| Extensão | Pré x 6 meses (164,4) (155,4) | 0,28 | extensão | Pré x 6 meses (177) (164,7) | 0,08 |
| Extensão | Pré x 12 meses (164,4) (154,2) | 0,057 | extensão | Pré x 12 meses (177) (158,8) | 0,15 |

* n grupo de estudo pré-operatório=22
† n grupo de estudo 3 meses=21
\# n grupo de estudo 6 meses=20
Δ n grupo de estudo 12 meses=17

◊ n grupo de controle pré-operatório=22
‡ n grupo de controle 3 meses=22
¥ n grupo de controle 6 meses=20
ß n grupo de controle 12 meses=16

Tabela 4 – Teste isocinético a 60 °/s. Avaliação de cada um dos grupos, separadamente

| | **Grupo de estudo** | | | **Grupo controle** | |
|---|---|---|---|---|---|
| **Teste isocinético** | **Comparação (Nm)** | **valor de *p*** | **Teste isocinético** | **Comparação (Nm)** | **valor de *p*** |
| Adução | Pré* x 3 meses† (86,0) (90,5) | 0,69 | adução | Pré ◊ x 3 meses ‡ (104,0) (103,5) | 0,92 |
| Adução | Pré x 6 meses # (86,0) (96,7) | 0,49 | adução | Pré x 6 meses ¥ (104,0) (103,6) | 0,90 |
| Adução | Pré x 12 meses Δ (86,0) (108,4) | 0,011 | adução | Pré x 12 meses ß (104,0) (106,2) | 0,42 |
| Abdução | Pré x 3 meses (50,3) (47,9) | 0,44 | abdução | Pré x 3 meses (61,0) (57,3) | 0,17 |
| Abdução | Pré x 6 meses (50,3) (48,6) | 0,92 | abdução | Pré x 6 meses (61,0) (55,5) | 0,11 |
| Abdução | Pré x 12 meses (50,3) (53,8) | 0,96 | abdução | Pré x 12 meses (61,0) (58,8) | 0,50 |
| Flexão | Pré x 3 meses (53,7) (48,7) | 0,11 | flexão | Pré x 3 meses (56,4) (54,3) | 0,26 |
| Flexão | Pré x 6 meses (53,7) (51,7) | 0,59 | flexão | Pré x 6 meses (56,4) (60,7) | 0,66 |
| Flexão | Pré x 12 meses (53,7) (53,1) | 0,68 | flexão | Pré x 12 meses (56,4) (56,3) | 0,42 |
| Extensão | Pré x 3 meses (138,4) (127,1) | 0,25 | extensão | Pré x 3 meses (152,3) (158,2) | 0,34 |
| Extensão | Pré x 6 meses (138,4) (142,0) | 0,98 | extensão | Pré x 6 meses (152,3) (155,4) | 0,76 |
| Extensão | Pré x 12 meses (138,4) (144,2) | 0,96 | extensão | Pré x 12 meses (152,3) (153,0) | 0,87 |

* n grupo de estudo pré-operatório=22
† n grupo de estudo 3 meses=21
\# n grupo de estudo 6 meses=20
Δ n grupo de estudo 12 meses=17

◊ n grupo de controle pré-operatório=22
‡ n grupo de controle 3 meses=22
¥ n grupo de controle 6 meses=20
ß n grupo de controle 12 meses=16

Tabela 5 – Comparação entre os grupos da variável diferença de força a 30 °/s

| **Variável (N)** | **Grupo Controle*** | **Grupo Estudo*** | **Valor de *p*** |
|---|---|---|---|
| Dif iso30 adu 3 meses | 1,75 | 0,33 | 0,83 |
| Dif iso30 adu 6 meses | -0,52 | 8,3 | 0,27 |
| Dif iso30 adu 12 meses | 6 | 0,11 | 0,33 |
| | | | |
| Dif iso30 abd 3 meses | -0,65 | -6,04 | 0,22 |
| Dif iso30 abd 6 meses | -0,52 | -4,68 | 0,34 |
| Dif iso30 abd 12 meses | 2,66 | -4,76 | 0,16 |
| | | | |
| Dif iso30 flex 3 meses | -2,85 | -5,54 | 0,4 |
| Dif iso30 flex 6 meses | -5,31 | -4,81 | 0,88 |
| Dif iso30 flex 12 meses | -2,8 | -7,11 | 0,35 |
| | | | |
| Dif iso30 ext 3 meses | -6,2 | -11,27 | 0,6 |
| Dif iso30 ext 6 meses | -13,8 | -8,36 | 0,6 |
| Dif iso30 ext 12 meses | -14 | -16,88 | 0,81 |

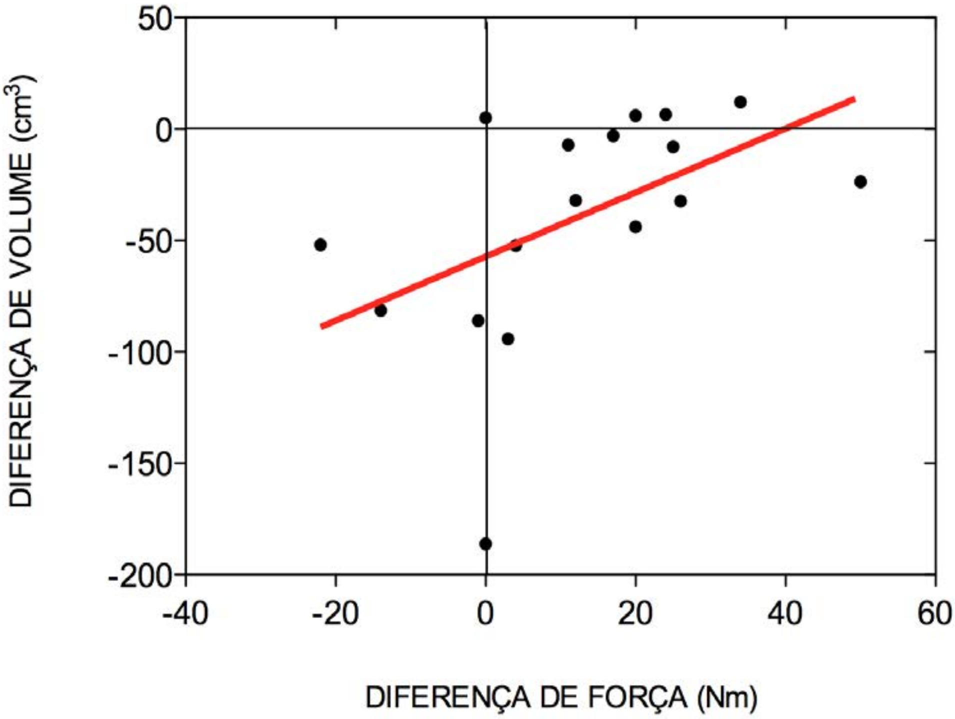
*Valores apresentados como média das diferenças (Nm)

Tabela 6 – Comparação entre os grupos da variável diferença de força a 60 $^{o}$/s

| **Variável (N)** | **Grupo Controle*** | **Grupo Estudo*** | **Valor de *p*** |
|---|---|---|---|
| Dif iso60 adu 3 meses | -0,5 | 2,59 | 0,7 |
| Dif iso60 adu 6 meses | -0,66 | 5 | 0,6 |
| Dif iso60 adu 12 meses | 7,35 | 12,29 | 0,62 |
| | | | |
| Dif iso60 abd 3 meses | -3,65 | -2,5 | 0,78 |
| Dif iso60 abd 6 meses | -5,77 | -0,35 | 0,29 |
| Dif iso60 abd 12 meses | -1 | 0,17 | 0,84 |
| | | | |
| Dif iso60 flex 3 meses | -2,85 | -5,54 | 0,43 |
| Dif iso60 flex 6 meses | -5,31 | -4,81 | 0,88 |
| Dif iso60 flex 12 meses | -2,8 | -7,11 | 0,35 |
| | | | |
| Dif iso60 ext 3 meses | 5,95 | -10,22 | 0,13 |
| Dif iso60 ext 6 meses | 2,55 | 0,15 | 0,84 |
| Dif iso60 ext 12 meses | 1,85 | 0,52 | 0,93 |

*Valores apresentados como média das diferenças (Nm)

Gráfico 3 – Correlação entre a diferença de volume e a diferença de força




Legenda: Teste isocinético de adução a 60 °/s após 12 meses da operação. Grupo de estudo- r= +0,5, *p*=0,04.

# 5 DISCUSSÃO

A gluteoplastia de aumento com implantes de silicone teve seu início com implantes especificamente desenvolvidos para os glúteos durante a década de 1970.[2] Sua evolução técnica foi lenta e a descrição da operação considerada padrão atualmente tardou 20 anos. Desde a publicação da técnica intramuscular por Vergara e Marcos em 1996,[10] a operação se popularizou entre pacientes e cirurgiões plásticos, assim como teve as bases anatômicas melhor definidas.[9,11,41] Simultaneamente, as complicações foram estudadas, desenvolvendo-se métodos diagnósticos de maior acurácia e alternativas técnicas para sua profilaxia e tratamento.[12,14,16,41] O momento atual é de compreendermos melhor o comportamento anatômico e funcional da musculatura envolvida na operação, assim como pesquisar possíveis alterações em médio prazo decorrentes da presença de material aloplástico no interior do músculo glúteo máximo.

A seleção da amostra realizada no ambulatório de Cirurgia Plástica do Hospital Universitário Pedro Ernesto da Uerj reflete o perfil das pacientes candidatas ao aumento das nádegas, mulheres predominantemente nas terceira e quarta década de vida, eutróficas e hígidas. A composição do grupo controle teve como escopo selecionar pacientes semelhantes àquelas do grupo de estudo, mormente nas características de massa corporal e proporção entre massa magra e percentual de gordura. A inclusão neste grupo de mulheres que seriam submetidas a outra operação foi importante por impor afastamento das atividades físicas por igual período em ambos os grupos. A plasticidade muscular e alterações no volume e na força do musculo estriado esquelético secundários ao desuso foram documentados previamente.[42,43] Este cuidado tem o objetivo de diferenciar alterações musculares próprias do período pós-operatório, consequentes ao afastamento das atividades físicas e desuso da musculatura, daquelas causadas pela operação e presença dos implantes.

A avaliação nutricional teve como objetivo não apenas aferir os parâmetros nutricionais analisados, mas também manter o controle nutricional das pacientes ao longo da pesquisa, evitando variações no IMC, uma vez que variações ponderais podem influenciar na relação entre atrofia e hipertrofia muscular.[43]

As características antropométricas na mulher, principalmente alguns parâmetros, como a circunferência da cintura e do quadril, são importantes indicadores de saúde.[44,45] A relação entre as medidas da circunferência da cintura e do quadril (RCQ) apresenta grande importância na estética corporal conforme demonstrado por Singh.[46] A fascinação pela figura da ampulheta representada por valores da RCQ próximos de 0,7 transcende aspectos culturais e étnicos, e fora identificada em diversas culturas ao longo de nossa história.[46] A escultura da Vênus de Milo, que possui RCQ de 0,68, é um exemplo deste conceito de beleza universalmente aceito.[47] A relação entre beleza e RCQ está presente também no aspecto evolutivo do ser humano. Valores próximos de 0,7 da RCQ indicam mulheres mais saudáveis, menos propensas ao desenvolvimento de doenças cardiovasculares [45] e maior potencial reprodutivo no desenvolvimento gestacional e no parto.[46] Existe maior atratividade para o sexo oposto de mulheres com estas características, que proporcionam melhor resultado na preservação e propagação do patrimônio genético individual,[46] sendo este o principal fator na evolução das espécies.

A comparação dos valores da RCQ entre os grupos apresentou diferença estatística. Pacientes candidatas ao aumento dos glúteos apresentaram RCQ maiores (média – 0,76) em detrimento aquelas que não possuem a intenção de realizar esta operação (média – 0,71). Mesmo sem ser alvo do objetivo consciente das pacientes quando solicitam o aumento das nádegas, elas manifestam o desejo de serem operadas quando possuem uma RCQ inadequada. Hong *et al.*[47] demonstraram que os padrões de beleza atuais possuem tendências semelhantes, no ocidente e oriente, para uma RCQ próxima de 0,7 e a busca desta proporção pode evitar insatisfações das pacientes durante o pós operatório. O procedimento cirúrgico mostrou-se eficaz como instrumento de mudança na RCQ, fazendo com que as pacientes submetidas ao aumento dos glúteos apresentassem valores mais próximos de 0,7 , considerado mais adequado esteticamente. Esta mudança no padrão da relação entre a cintura e o quadril é absolutamente estética, e, apesar da não realização de avaliação cardiovascular, não se espera que seja alterada com a operação.

O padrão de distribuição da gordura corporal, classificado em androide e ginoide, possui estreita relação com a medida da RCQ, uma vez que o padrão androide concentra a gordura no tronco e braços, e o padrão ginoide nas pernas e cintura pélvica.[39] Todas as pacientes da amostra que possuíam padrão androide antes da operação faziam parte do grupo de estudo, ou seja, desejavam realizar a operação para o aumento das nádegas. Após a operação, a mudança na classificação de androide para ginoide em todos os casos mostra a capacidade de melhora do contorno corporal obtido com tal procedimento.

A tomografia computadorizada foi utilizada previamente em diferentes situações no estudo da região glútea,[20,41] assim como a reconstrução volumétrica em 3D na avaliação do posicionamento de diferentes tipos de implantes corporais.[41,48,49] O posicionamento dos implantes foi verificado em estudo prévio de outra série de casos, por compreender o período em que utilizávamos as próteses em diferentes posições, considerando as diferentes indicações clínicas. Após três meses da operação, todos os implantes ovais mantiveram inclinação semelhante à das fibras do músculo glúteo máximo.[41] Por tratar-se de músculo estriado esquelético, e principalmente por ser um músculo envolvido com a postura e estabilização da pelve durante a movimentação em posição ereta, além do tônus basal próprio deste tecido, o músculo glúteo máximo apresenta-se como uma unidade dinâmica, sendo constantemente recrutado em diferentes ações como andar, correr e saltar.[50] Creditamos à constante atividade muscular e consequente pressão intermitente sobre os implantes a causa para manutenção dos implantes na mesma inclinação do músculo. Considerando-se que nos casos em que os implantes não são inseridos nessa direção, sua rotação pode ocorrer em diferentes sentidos no plano coronal (horário ou anti-horário), nos lados direito e esquerdo. Assim, recomenda-se a introdução de todos os implantes de base oval em posição oblíqua, com a mesma inclinação das fibras, para evitar assimetrias no período pós-operatório. A rotação de implantes inseridos em lojas musculares demasiadamente grandes ocorre pela grande mobilização glútea decorrente do ato de sentar [41] e as características intrínsecas do músculo citadas acima. A possibilidade de rotação de implantes de silicone anatômicos em gel de alta coesividade foi estudada previamente nas mamas com incidência variando entre 1% e 5%.[51] A ausência de desenvolvimento de tecido conectivo entre os implantes e a capsula fibrosa permite com que os implantes se movimentem livremente dentro da cápsula, corroborando com a hipótese de que dissecções mais amplas aumentam a incidência de rotação. [51]

A tomografia computadorizada é utilizada para reconstrução 3D e a volumetria de tecidos ósseos e partes moles com frequência demonstra bons resultados, dada a facilidade de manipulação das imagens com os diversos *softwares* disponíveis.[41,48,52] O isolamento do tecido muscular para reconstrução 3D foi realizada pelo programa *Extended brilliance™ workspace* por permitir esta seleção através da diferença de densidade dos tecidos, evitando-se a seleção manual e possíveis variações decorrentes de erro humano. A curva de evolução do volume muscular foi distinta nas pacientes com próteses glúteas quando comparada com as pacientes do grupo controle. (Gráfico 2) O músculo apresentou atrofia quando submetido à operação para introdução de implantes e, apesar do volume após 12 meses ser diferente do volume pré-operatório, o gráfico apresenta curva ascendente após três meses da operação (período em que a paciente encontra-se liberada para prática desportiva), demonstrando tendência à recuperação deste volume. Em estudo prévio, demonstramos, em uma série de 17 pacientes, atrofia de 4,3% e 2,6% para os lados direito e esquerdo, respectivamente, porém sem diferença estatística entre os volumes de pré-operatório e 12 meses.[41] Os gráficos que representam o volume do músculo glúteo máximo em relação ao tempo possuem curvas de evolução semelhantes em ambos os estudos. A média de volume dos implantes usado por Serra *et al*. foi de 313 $cm^3$, menor que a média dos implantes utilizados neste estudo, 356 $cm^3$. A diferença de volume dos implantes pode ser um fator determinante na atrofia muscular e deve ser estudada no futuro. A pequena amostra deste artigo (n=17) também deve ser considerada no resultado, pois o atual estudo utilizando a mesma metodologia aplicada em uma amostra maior (n=22) foi capaz de detectar diferença entre os volumes musculares, contrariamente ao ocorrido na avaliação da amostra menor. Nosso objetivo é reavaliar, anualmente, as pacientes, para determinar a evolução do músculo em longo prazo.

A variável diferença de volume (dif vol) foi criada para comparação entre os grupos do volume muscular em seu caráter evolutivo. Desta forma, evita-se a comparação entre as médias, pois é esperado que esta seja sempre diferente entre os grupos, haja vista que se constitui em um viés de seleção.

As pacientes candidatas à operação para aumento de glúteos, o são, predominantemente, por possuírem pouco volume muscular nessa região anatômica. O resultado demonstrou diferença estatística de grande significância em todos os momentos da pesquisa (três, seis e 12 meses após a operação), demonstrando que as portadoras de implantes intramusculares apresentam atrofia muscular e, depois de isolados alguns fatores, como desuso da musculatura, alterações nutricionais e diferenças individuais de massa corporal, pode-se inferir que o principal fator responsável por esta alteração são os implantes de glúteo. O tecido muscular estriado esquelético apresenta constante renovação que irá depender da relação entre a síntese e a degradação de proteínas em seu interior.[43] Sato *et al*.[43] estudaram a interação de diversos fatores em condições anabólicas e catabólicas, demonstrando a inatividade como adjuvante na perda de massa muscular.

Breuls *et al*.[53] demonstraram *in vitro* a suscetibilidade da célula muscular para danos secundários a compressão, mencionando o papel de órteses e próteses como fatores adicionais neste mecanismo de injúria celular. Diversos estudos experimentais [32-35,54] documentaram, por meio de diferentes métodos, a lesão do tecido muscular estriado esquelético em ratos decorrente da compressão externa, principalmente nas regiões de proeminências ósseas, como a tuberosidade isquiática no desenvolvimento de úlceras de pressão. Nossos resultados demonstram que a atrofia muscular também ocorre no músculo glúteo máximo quando introduzidos implantes na intimidade de suas fibras, corroborando os dados existentes na literatura que propõe a compressão como fator na atrofia devido ao estado de deformação celular,[53] independentemente da via de compressão ser intrínseca ou extrínseca.

O teste isocinético é uma situação em que o músculo se contrai a velocidade acomodativa controlada, o que leva o segmento a mover-se em velocidade linear ou angular constante, dentro de um setor prescrito de sua amplitude de movimento. Como instrumento na pesquisa científica, é de grande validade para acessar a performance muscular dinâmica e estática, registrando parâmetros, como torque máximo (Nm), trabalho (J/min) e potência (W).[55] Ao contrário do teste muscular manual, apresenta boa confiabilidade e reprodutibilidade para detectar diferenças sutis na performance muscular em indivíduos capazes de gerar força que movimente o segmento em sua amplitude de movimento contra a gravidade e contra uma resistência, apresentando valores que em teoria são mais realistas em relação à capacidade funcional muscular máxima.[55] As velocidades permitidas pelo equipamento são de 30, 60, 90, 120 e 180 °/s. Considerando a relação força *vs*. velocidade de contração, a menor velocidade permitirá maior força de contração.[55,56]

As velocidades de 30 °/s e 60 °/s foram selecionadas objetivando-se conseguir valores de força próximos aos isométricos, medindo o torque ativo máximo resultante do que cada indivíduo pode produzir pela amplitude de movimento.[55,56] A presença de variação do volume e atrofia do músculo glúteo máximo quando submetido à introdução de implantes em seu interior foi demonstrada previamente.[41] Essa observação suscitou o questionamento sobre possíveis alterações no funcionamento muscular como unidade contrátil e em sua capacidade de gerar força. Trappe *et al*. [42] documentaram, por meio do estudo de astronautas em gravidade zero, as alterações musculares causadas pela inatividade e a possibilidade de sua prevenção, com a prescrição de exercícios físicos. A criação do grupo controle com pacientes que permaneceram em inatividade física pelo mesmo período que o grupo de estudo teve como objetivo eliminar o viés da inatividade e avaliar as alterações causadas primariamente em decorrência da operação de aumento glúteo.

Bartlett *et al*.[50] documentaram, por eletromiografia, a função do músculo glúteo máximo em diferentes situações, como andar, correr, saltar, escalar, assim como em ações secundárias para a estabilização do tronco e da pelve. O teste isocinético avaliou quatro diferentes movimentos (adução, abdução, flexão e extensão), considerando a ampla função do músculo em questão, na tentativa de observar quaisquer mudanças que nele ocorresse. Os resultados da avaliação de força muscular no grupo de estudo apresentaram diminuição de força no movimento de flexão a 30 °/s em todos os períodos de avaliação. A ação concêntrica primária do músculo glúteo máximo é a extensão da coxa,[50] portanto, durante a flexão, o músculo glúteo atua como antagonista.[57] A presença de diminuição de força no mesmo teste no grupo controle nos leva a creditar esta alteração à inatividade muscular, possivelmente relacionada aos músculos da região anterior da coxa e quadril envolvidos primariamente com a flexão.[58] As forças que atuam na movimentação da articulação do quadril, atuam em conjunto e sendo sua resultante o produto da interação harmônica entre os grupos musculares agonistas e antagonistas para cada movimento.[57,59] A desarmonia nessa relação, gerando excesso de força anterior ou posterior na articulação do quadril, pode levar a instabilidade e futuras lesões.[57] Nossos resultados, ao demonstrarem aumento de força de flexão, sem alterações na força de extensão, suscitam a possibilidade de lesões futuras na articulação do quadril. Devemos portanto acompanhar estas pacientes em longo prazo com teste isocinético para melhor avaliação articular. O teste isocinético a 60 °/s apresentou como única alteração o aumento de força durante a adução após 12 meses no grupo de estudo. O músculo glúteo máximo, sobretudo sua porção superior, apresenta grande atividade durante a abdução da coxa.[50] O aumento de força na adução, movimento em que o glúteo atua como antagonista, e a falta de correspondência na avaliação do grupo controle nos leva à conclusão de que o principal fator para que isso tenha ocorrido seja a operação. O teste isocinético avalia a força da musculatura agonista em determinado movimento articular.[55] O aumento na força de adução do grupo de estudo pode ser decorrente do aumento de força na musculatura adutora, diminuição de força na musculatura abdutora ou ambos. O fato da operação não abordar o grupamento adutor nos faz concluir que o fator principal desta alteração seria diminuição na força do músculo glúteo na sua função de antagonista e por isso não foi detectada no teste isocinético. O teste de abdução, em que os glúteos atuam como agonistas, não apresentaram alterações.

A variável diferença de força (Dif iso), em similaridade à Dif vol, tem como objetivo avaliar a evolução de força muscular em função do tempo e permitir a comparação entre os grupos estudados. Não foram observadas diferenças entre os grupos de estudo e controle no que concerne à variação de força muscular nos períodos de três, seis e 12 meses em relação ao valor obtido no pré-operatório. Portanto, a realização da operação para aumento de glúteos e a permanência de implantes no interior do músculo glúteo máximo não interfere nas variações fisiológicas de força deste músculo, que é influenciada por diversos fatores, como inatividade, alongamento, treinamento etc.[42,43,60,61] Esta preservação de força pode ser consequência da utilização de instrumentos rombos durante a dissecção, em que não o músculo não é incisado, corroborando o relato de Socolovsky & Masi,[62] que mostraram que abordagens glúteas sem incisão das fibras musculares produzem menor trauma cirúrgico e melhor recuperação.

A relação entre hipertofia e força muscular foi pesquisada anteriormente e varia em função de diversos fatores.[60,61,63] Realizou-se o cálculo de correlação entre as diferenças de volume e força, em todos os movimentos e velocidades utilizados no teste isocinético. A presença de significância estatística apenas na adução a 60 $^{o}$/s no grupo de estudo, e ausência de correlação nos demais movimentos testados mostra que força e volume muscular não variam de maneira conjunta. Diversos estudos mostram que o tipo de treinamento aplicado influenciará quantitativamente no aumento da massa muscular e ganho de força.[60,64-66] Após a liberação para atividades físicas ocorrida com três meses de pós-operatório, as pacientes realizaram atividades de acordo com sua preferência, variando amplamente o tipo de treinamento, intensidade e período em que foi realizado. Lundberg *et al*.[66] demonstraram que diferentes tipos de treinamento alteram não somente a forca e volume do músculo, mas fazem também variar a relação existente entre estas duas variáveis. Ballak *et al*.[67] demonstraram que o produto final da força muscular depende da interação entre vários fatores, como massa muscular, número e comprimento das fibras, distribuição dos tipos de fibras e tensão muscular. O momento gerado pelo comprimento do membro também pode exercer influência na força.[68] A interação entre estes fatores varia entre as espécies animais e dentro de uma mesma espécie.[67] A dificuldade de seleção de mulheres com o mesmo comprimento de membros inferiores e a impossibilidade ética do estudo da fibra muscular através de biópsia nos limitou na avaliação destes inúmeros fatores envolvidos com o funcionamento muscular.

A complexidade funcional do grupamento muscular glúteo se reflete no amplo espectro de alterações corporais em consequência das mudanças nestes músculos.[50,57] Johnson [58] demonstrou que o complexo formado pelas articulações lombar, pélvica e do quadril, juntamente com sua musculatura, está relacionado com o funcionamento da cintura escapular e, possivelmente, envolvido com algumas lesões que ocorrem nessa região. Lewis *et al.*[57] demonstraram que alterações nas diversas forças que atuam na articulação do quadril podem ser a causa de dor articular e desenvolvimento de lesões. Neste estudo, correlacionou-se apenas dois fatores, massa e força muscular. A ausência de correlação observada na maioria dos casos se explica pela presença de diversos fatores envolvidos na biomecânica muscular, que não se constituíram em objetivo deste estudo.

Este é o primeiro estudo acerca da função do músculo glúteo máximo após gluteoplastias de aumento com implantes e constitui a primeira etapa de uma pesquisa mais complexa e abrangente, envolvendo diversos aspectos, como a sensibilidade glútea, importância do tamanho dos implantes, propriocepção, mudanças na qualidade de vida, função sexual e satisfação com o procedimento.

# CONCLUSÕES

O músculo glúteo máximo apresenta atrofia secundariamente à realização de gluteoplastia para introdução de implantes no interior de sua massa, após 12 meses de evolução.

As variações na força do músculo glúteo máximo nesse período não podem ser atribuídas primariamente à operação ou à presença dos implantes em seu interior, sendo consideradas fisiológicas e multifatoriais.

Os implantes de base oval adotam posição oblíqua com inclinação semelhante àquela das fibras musculares.

O aumento de glúteos com implantes foi eficaz na melhora da relação entre a cintura e o quadril, assim como na mudança dos padrões antropométricos (de androide para ginoide).

# REFERÊNCIAS

1. Morimoto N, Zollikofer CP, Ponce de León MS. Shared human-chimpanzee pattern of perinatal femoral shaft morphology and its implications for the evolution of hominin locomotor adaptations. PLoS One. 2012;7(7):e41980.

2. de la Peña JA, Rubio OV, Cano JP, Cedillo MC, Garces MT. History of gluteal augmentation. Clin Plast Surg. 2006;33(3):307-319.

3. Aboudib JH, Serra F, de Castro CC. Gluteal augmentation: technique, indications, and implant selection. Plast Reconstr Surg.2012;130(4):933-935.

4. Bartels RJ, O'Malley JE, Douglas WM, Wilson RG. Unusual use of the Cronin breast prothesis. Plast Reconstr Surg. 1969;44(5):500.

5. Cocke WM, Ricketson G. Gluteal augmentation. Plast Reconstr Surg. 1973;52(1):93.
6. González-Ulloa M. Gluteoplasty: A ten-year report. Aesthetic Plast Surg. 1991;15(1):85-91.

7. Mendieta CG. Gluteoplasty. Aesthet Surg J. 2003;23(6):441-455.

8. Robles JM, Tagliapietra JC, Grandi MA. Gluteoplastia de aumento: implante submuscular. Cir Plast Iberolatinoam. 1984;10(4):365-375.

9. Serra F, Aboudib JH, Cedrola JP, de Castro CC. Gluteoplasty: anatomic basis and technique. Aesthet Surg J. 2010;30(4):579-592.

10. Vergara R, Marcos M. Intramuscular gluteal implants. Aesthetic Plast Surg. 1996;20(3):259-262.

11. Gonzalez R. Augmentation gluteoplasty: the XYZ method. Aesthetic Plast Surg. 2004;28(6):417-425.

12. Serra F, Aboudib JH, Marques RG. Reducing wound complications in gluteal augmentation surgery. Plast Reconstr Surg. 2012;130(5):706e-713e.

13. Mofid MM, Gonzalez R, de la Peña JA, Mendieta CG, Senderoff DM, Jorjani S. Buttock augmentation with silicone implants: a multicenter survey review of 2226 patients. Plast Reconstr Surg. 2013;131(4):897-901.

14. Bruner TW, Roberts TL 3rd, Nguyen K. Complications of buttocks augmentation: diagnosis, management, and prevention. Clin Plast Surg. 2006;33(3):449-466.

15. de la Peña JA. Subfascial technique for gluteal augmentation. Aesthet Surg J 2004;24(3):265-273.

16. Flores-Lima G, Eppley BL, Dimas JR, Navarro DE. Surgical pocket location for gluteal implants: a systematic review. Aesthetic Plast Surg. 2013;37(2):240-245.

17. Gonzalez R. Late intracapsular seroma in subfascial buttock augmentation: a case report. Aesthetic Plast Surg. 2006;30(5):599-604.

18. Centeno RF, Young VL. Clinical anatomy in aesthetic gluteal body contouring surgery. Clin Plast Surg. 2006;33(3):347-358.

19. Lee EI, Roberts TL, Bruner TW. Ethnic considerations in buttock aesthetics. Semin Plast Surg. 2009;23(3):232-243.

20. Nicareta B, Pereira LH, Sterodimas A, Illouz YG. Autologous gluteal lipograft. Aesthetic Plast Surg 2011;35(2):216-224.

21. Raposo-Amaral CE, Cetrulo CL Jr, Guidi Mde C, Ferreira DM, Raposo-Amaral CM. Bilateral lumbar hip dermal fat rotation flaps: a novel technique for autologous augmentation gluteoplasty. Plast Reconstr Surg. 2006;117(6):1781-1788.

22. Azevedo DM, Gonçalves P, Pereira J, Amoedo TB, Kuroyanagi FM, Cotes EFM, Pinto EBS, Saldanha OR. Augmentation gluteoplasty: experience at Dr. Ewaldo Bolivar de Souza Pinto Plastic Surgery Service. Rev Bras Cir Plast. 2012;27(1):87-92.

23. Mathes SJ, Nahai F. Classification of the vascular anatomy of muscles: experimental and clinical correlation. Plast Reconstr Surg.1981;67(2):177-187.

24. Hwang K, Nam YS, Han SH, Hwang SW. The intramuscular course of the inferior gluteal nerve in the gluteus maximus muscle and augmentation gluteoplasty. Ann Plast Surg. 2009;63(4):361-365.

25. Song AY, Askari M, Azemi E, Alber S, Hurwitz DJ, Marra KG, et al. Biomechanical properties of the superficial fascial system. Aesthet Surg J. 2006;26(4):395-403.

26. Hidalgo JE. Submuscular gluteal augmentation: 17 years of experience with gel and elastomer silicone implants. Clin Plast Surg. 2006;33(3):435-447.

27. Pokorný D, Jahoda D, Veigl D, Pinskerová V, Sosna A. Topographic variations of the relationship of the sciatic nerve and the piriformis muscle and its relevance to palsy after total hip arthroplasty. Surg Radiol Anat. 2006;28(1):88-91.

28. Xaymardan M, Gibbins JR, Zoellner H. Adipogenic healing in adult mice by implantation of hollow devices in muscle. Anat Rec. 2002;267(1):28-36.

29. Chae J, Hart R. Intramuscular Hand Neuroprosthesis for Chronic Stroke Survivors. Neurorehabil Neural Repair. 2003;17(2):109-117.

30. Harrison D, Selvaggi G. Gluteal augmentation surgery: indications and surgical management. J Plast Reconstr Aesthet Surg. 2007;60(8):922-928.

31. Alperovich M, Schreiber JE, Singh NK. Infection after augmentation gluteoplasty in a pregnant patient. Aesthet Surg J. 2007;27(6):622-625.

32. Linder-Ganz E, Engelberg S, Scheinowitz M, Gefen A. Pressure-time cell death threshold for albino rat skeletal muscles as related to pressure sore biomechanics. J Biomech. 2006;39(14):2725-2732.

33. Linder-Ganz E, Gefen A. Mechanical compression-induced pressure sores in rat hindlimb: muscle stiffness, histology, and computational models. J Appl Physiol. 2004;96(6):2034-2049.

34. Siu PM, Tam EW, Teng BT, Pei XM, Ng JW, Benzie IF, Mak AF. Muscle apoptosis is induced in pressure-induced deep tissue injury. J Appl Physiol. 2009;107(4):1266-1275.

35. Stekelenburg A, Oomens CW, Strijkers GJ, Nicolay K, Bader DL. Compression-induced deep tissue injury examined with magnetic resonance imaging and histology. J Appl Physiol. 2006;100(6):1946-1954.

36. Gonzalez R. Etiology, definition, and classification of gluteal ptosis. Aesthetic Plast Surg. 2006;30(3):320-326.

37. Cuenca-Guerra R, Quezada J. What makes buttocks beautiful? A review and classification of the determinants of gluteal beauty and the surgical techniques to achieve them. Aesthetic Plast Surg. 2004;28(5):340-347.

38. Jellife DB. The assessment of the nutritional status of the community (with special reference to field surveys in developing regions of the world). Monogr Ser World Health Organ. 1966;53:3-271.

39. Cao Y, Zhang S, Zou S, Xia X. The relationship between endogenous androgens and body fat distribution in early and late postmenopausal women. PLoS One. 2013;8(3):e58448.

40. van Cingel EHR, Kleinrensink GJ, Rooijens PPGM, Uitterlinden EJ, Aufdemkampe G, Stoeckart R. Learning effect in isokinetic testing of ankle invertors and evertors. Isokinet Exerc Sci. 2001;9(1):171-177.

41. Serra F, Aboudib JH, Marques RG. Intramuscular technique for gluteal augmentation: determination and quantification of muscle atrophy and implant position by computed tomographic scan. Plast Reconstr Surg. 2013;131(2):253e-259e.

42. Trappe S, Costill D, Gallagher P, Creer A, Peters JR, Evans H, Riley DA, Fitts RH. Exercise in space: human skeletal muscle after 6 months aboard the International Space Station. J Appl Physiol (1985). 2009;106(4):1159-1168.

43. Sato S, Shirato K, Tachiyashiki K, Imaizumi K. Muscle plasticity and *β2*-adrenergic receptors: adaptive responses of *β2*-adrenergic receptor expression to muscle hypertrophy and atrophy. J Biomed Biotechnol. 2011;2011:729598.

44. Olinto MT, Nacul LC, Gigante DP, Costa JS, Menezes AM, Macedo S. Waist circumference as a determinant of hypertension and diabetes in Brazilian women: a population-based study. Public Health Nutr. 2004;7(5):629-635.

45. Klein S, Allison DB, Heymsfield SB, Kelley DE, Leibel RL, Nonas C, Kahn R. Waist circumference and cardiometabolic risk: a consensus statement from Shaping America's Health: Association for Weight Management and Obesity Prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. Am J Clin Nutr. 2007;85(5):1197–1202.

46. Singh D. Universal allure of the hourglass figure: an evolutionary theory of female physical attractiveness. Clin Plast Surg. 2006;33(3):359-370.

47. Hong YJ, Park HS, Lee ES, Suh YJ. Anthropometric analysis of waist-to-hip ratio in Asian women. Aesthetic Plast Surg. 2009;33(2):185-190.

48. Kestin LL, Jaffray DA, Edmundson GK, Martinez AA, Wong JW, Kini VR, et al. Improving the dosimetric coverage of interstitial high-dose-rate breast implants. Int J Radiat Oncol Biol Phys. 2000;46(1):35-43.

49. Wang M, Gui L, Liu XJ. Visualization of Medpor implants using surface rendering. Chin Med J (Engl). 2011;124(18):2890-2893.

50. Bartlett JL, Sumner B, Ellis RG, Kram R. Activity and functions of the human gluteal muscles in walking, running, sprinting, and climbing. Am J Phys Anthropol. 2014;153(1):124-131.

51. Sampaio Góes JC. Breast implant stability in the subfascial plane and the new shaped silicone gel breast implants. Aesthetic Plast Surg. 2010;34(1):23-28.

52. Papageorgiou KI, Mancini R, Garneau HC, Chang SH, Jarullazada I, King A, et al. A three-dimensional construct of the aging eyebrow: the illusion of volume loss. Aesthet Surg J. 2012;32(1):46-57.

53. Breuls RG, Bouten CV, Oomens CW, Bader DL, Baaijens FP. Compression induced cell damage in engineered muscle tissue: an in vitro model to study pressure ulcer aetiology. Ann Biomed Eng. 2003;31(11):1357-1364.

54. Schwartz LM. Atrophy and programmed cell death of skeletal muscle. Cell Death Differ. 2008;15(7):1163-1169.

55. Aquino a D r c io RS Silva P P Ocarino M onseca S A til i aç o da dinamometria isocin tica nas i nc ias do esporte e Reabilitaç o R bras Ci e Mov. 2007;15(1):93-100.

56. Reichard LB, Croisier JL, Malnati M, Katz-Leurer M, Dvir Z. Testing knee extension and flexion strength at different ranges of motion: an isokinetic and eletromyographic study. Eur J Appl Physiol. 2005;95(4):371-376.

57. Lewis CL, Sahrmann SA, Moran DW. Anterior hip joint force increases with hip extension, decreased gluteal force, or decreased iliopsoas force. J Biomech. 2007;40(16):3725-3731.

58. Johnson R. Lumbo-pelvic angular kinematics in youth baseball pitchers after a simulated game. Br J Sports Med. 2014;48(7):613.

59. Lewis CL, Sahrmann SA, Moran DW. Effect of position and alteration in synergist muscle force contribution on hip forces when performing hip strengthening exercises. Clin Biomech (Bristol, Avon). 2009;24(1):35-42.

60. Erskine RM, Fletcher G, Folland JP. The contribution of muscle hypertrophy to strength changes following resistance training. Eur J Appl Physiol. 2014 Mar 9. 2014; 114(6):1239-1249.

61. Van Roie E, Delecluse C, Coudyzer W, Boonen S, Bautmans I. Strength training at high versus low external resistance in older adults: effects on muscle volume, muscle strength, and force-velocity characteristics. Exp Gerontol. 2013;48(11):1351-1361.

62. Socolovsky M, Masi GD. Exposure of the sciatic nerve in the gluteal region without sectioning the gluteus maximus: Analysis of a series of 18 cases. Surg Neurol Int. 2012;3:15.

63. Harber MP, Konopka AR, Undem MK, Hinkley JM, Minchev K, Kaminsky LA, et al. Aerobic exercise training induces skeletal muscle hypertrophy and age-dependent adaptations in myofiber function in young and older men. J Appl Physiol (1985). 2012;113(9):1495-1504.

64. Deley G, Laroche D, Babault N. Effects of electrical stimulation pattern on quadriceps force production and fatigue. Muscle Nerve. 2014 Feb 12. 2014; 49(5):760-763.

65. Barak Y, Ayalon M, Dvir Z. Spectral EMG changes in vastus medialis muscle following short range of motion iskinetic training. J Electromyogr Kinesiol. 2006;16(5):403-412.

66. Lundberg TR, Fernandez-Gonzalo R, Tesch PA. Exercise-induced AMPK activation does not interfere with muscle hypertrophy in response to resistance training in men. J Appl Physiol (1985). 2014;116(6):611-620.

67. Ballak SB, Degens H, de Haan A, Jaspers RT. Aging related changes in determinants of muscle force generating capacity: A comparison of muscle aging in men and male rodents. Ageing Res Rev. 2014;14C:43-55.

68. Baxter JR, Piazza SJ. Plantar flexor moment arm and muscle volume predict torque-generating capacity in young men. J Appl Physiol (1985). 2014;116(5):538-544.

**APÊNDICE A** - Termo de consentimento livre e esclarecido

**TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO**

(De acordo com as normas da Resolução n.º 196, do Conselho Nacional de Saúde de 10/10/96)

Você está sendo convidado para participar da pesquisa ***ESTUDO DO COMPORTAMENTO MUSCULAR APÓS GLUTEOPLASTIA***. Você foi selecionado aleatóriamente e sua participação não é obrigatória. A qualquer momento, você pode desistir de participar e retirar seu consentimento. Sua recusa não trará nenhum prejuízo em sua relação com o pesquisador ou com a instituição, apesar de ter a possibilidade de obter diagnóstico precoce em caso de complicações.

O objetivo deste estudo é avaliar o comportamento da musculatura glútea quando submetida a intervenção cirúrgica para aumento volumétrico, visando oferecer melhores resultados e baixos índices de complicações.

Sua participação nesta pesquisa consistirá em realizar exames de tomografia computadorizada e testes de força muscular em laboratório específico, no período pré-operatório e após três, seis e 12 meses da operação.

Os únicos riscos relacionados com sua participação são danos ao feto, no caso de pacientes gestantes.

Os benefícios relacionados com a sua participação são a cooperação com o desenvolvimento científico e a possibilidade de ter possíveis complicações pós-operatórias diagnosticadas precocemente.

As informações obtidas com dessa pesquisa serão confidenciais e asseguramos o sigilo sobre sua participação. Os dados não serão divulgados de forma a possibilitar sua identificação.

Você receberá uma cópia deste Termo, onde consta o telefone e o endereço do pesquisador principal, podendo tirar suas dúvidas sobre o projeto e sua participação, agora ou a qualquer momento.

Rio de Janeiro, _______ de _______________ de _________ .

___________________________________________________________

Assinatura do voluntário

**Pesquisador responsável: FERNANDO SERRA**

______________________________________________________

**Endereço**: Rua Visconde de Pirajá 550, sala 1413– Ipanema – Rio de Janeiro, RJ.

**Telefones**: (21) 991769718 / 25125427.

**APÊNDICE B -** Gluteoplasty: anatomic Basis and technique - Primeiro artigo publicado

Body Contouring

Aesthetic Surgery Journal
30(4) 579–592

DOI: 10.1177/1090820X10380389
www.aestheticsurgeryjournal.com
SAGE

# Gluteoplasty: Anatomic Basis and Technique

Fernando Serra, MD; José Horácio Aboudib, MD; Juan Pedro Visser Cedrola, MD; and Claudio Cardoso de Castro, MD

**Abstract**

**Background:** Although the placement of implants for gluteal augmentation is becoming more common, the procedure still faces strong resistance from patients and some surgeons as a result of unsatisfactory outcomes in the past.

**Objective:** The authors describe easily-identifiable anatomic reference points that can assist the surgeon in the performance of gluteoplasty, making the procedure simpler and safer.

**Methods:** Based on a literature review, an anatomic study was performed of dissections of the gluteal region in seven formalinized and fresh cadavers. This study allowed the authors to observe anatomic details and propose bony reference points to guide gluteoplastic surgery. Between July 2006 and February 2009, 105 patients underwent gluteoplasty according to the guidelines resulting from the cadaveric study.

**Results:** All patients were female, ages 22 to 50 years. The surgical procedure, once refined, resulted in a low complication rate. In the final 50 patients in the series, there was only one seroma, one wound infection, and no cases of dehiscence. Bruising on the side of the thigh was encountered in four of the total 105 cases (3.8%). The clinical photos demonstrate the positive aesthetic results of this technique.

**Conclusions:** When gluteoplasty is performed utilizing a systematic strategy based on bone anatomy references, it can be a predictable procedure with reproducible results and minimal complications.

**Keywords**

gluteoplasty, implants, fat grafting, buttocks

Accepted for publication July 23, 2009.

Historically, various implants have been placed to augment the gluteal region. Bartels et al,[1] in 1969, were the first authors to describe gluteal reconstruction with breast implants. The procedure gained increased acceptance after Cocke and Ricketson described the placement of a silastic pancake prosthesis for correcting lateral gluteal depression in the 1970s, after González-Ulloa popularized and refined the technique as a cosmetic procedure with a subcutaneous pocket in 1991, and after implants were developed specifically for the gluteal area.[1-6] Since then, several techniques for gluteal implantation have been proposed, differing mainly with respect to implant location. González-Ulloa[4,7] described augmentation under the subcutaneous layer. De la Peña[7,8] employed a subfascial approach, Vergara and Marcos[7,9] an intramuscular approach, and Robles et al[7,10] a submuscular placement (Figure 1). Nevertheless, many plastic surgeons are reluctant to perform gluteal augmentation with implants because of the risk of problems and complications such as sciatic nerve injury.

To resolve these difficulties, we propose a surgical technique based on fixed anatomic reference points that simplify the operation and provide predictable and highly reproducible results while avoiding the most common complications.

## ANATOMY

The gluteus maximus muscle is the thickest muscle in the human body, ranging from 4 to 7 cm. It originates in the

From the Division of Plastic Surgery, University of the State of Rio de Janeiro, Brazil.
The authors are members of the Brazilian Society of Plastic Surgery.

**Corresponding Author:**
Fernando Serra, MD, Visconde de Pirajá,-547, -624/625, Ipanema, Rio de Janeiro-RJ, Brazil.
E-mail: fserrag@gmail.com

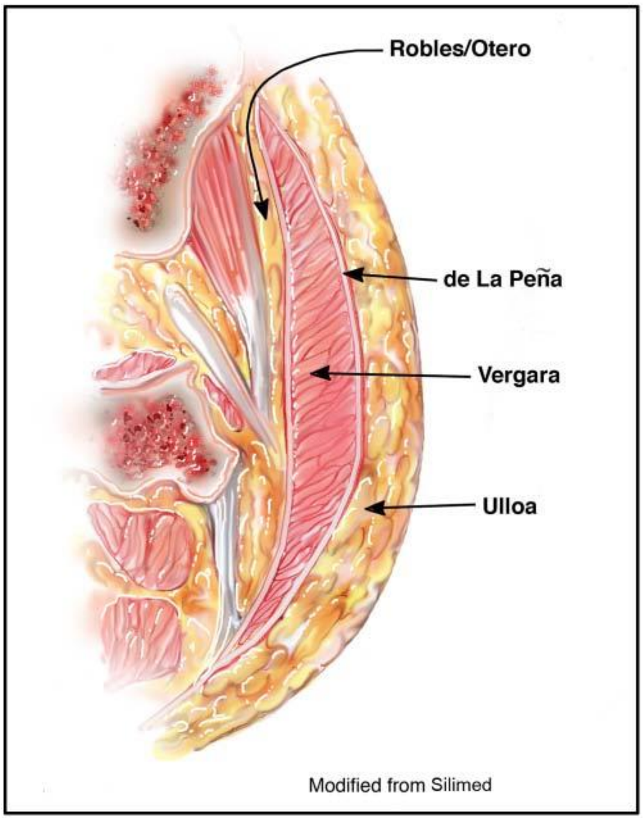



**Figure 1.** Proposed implant positions: subcutaneous (González-Ulloa), subfascial (De la Peña), intramuscular (Vergara), and submuscular (Robles).

iliac crest, ileum, sacrum, coccyx, and sacrum tuberal ligament, with insertions in the rough line and gluteal tuberosity of the femur and the ileotibial tract of fascia lata.[11-16] The muscle acts as a powerful extensor of the thigh and stabilizes the pelvis during movements where strength is required, such as sitting up and running.[5,12] It is vascularized by two major pedicles (type III, according to Mathes and Nahai), the upper and lower gluteus arteries (Figure 2).[13,14] The piriform muscle originates from the sacrum and sacrotuberal ligament and inserts on the top edge of the greater trochanter of the femur.[12,14,15] It is highly important because it splits the higher sciatic foramen, with the sciatic nerve passing inferiorly (Figure 2B).[12,15,16]

## Sciatic Nerve

The sciatic nerve is the largest nerve of the human body, comprising the tibial and fibular nerve, exiting the pelvis below the piriform muscle (Figure 3). Anatomic variations are found in about 30% of cases, as when the nerve is located above or through the piriform muscle or passage of the fibular and tibial nerves separately above and below the muscle. However, with the intramuscular technique, the nerve will always be protected by a muscular layer, even in cases of anatomic variations (Figure 4).[12,14,15]

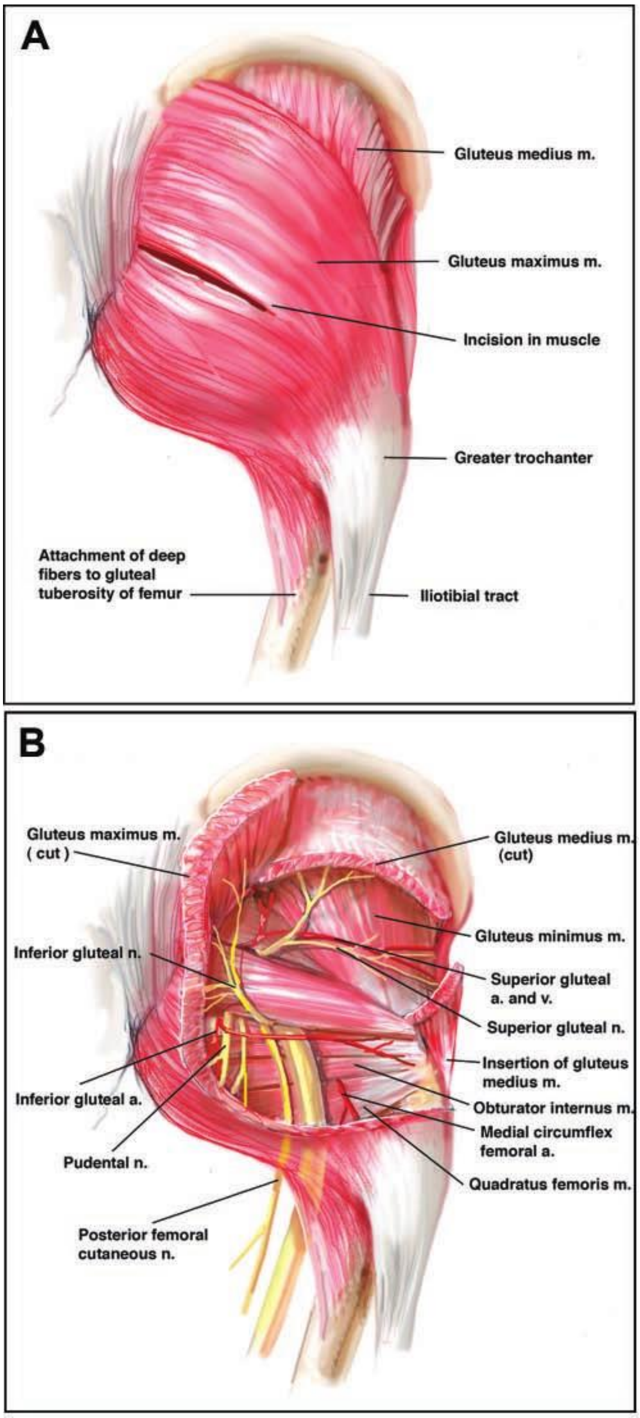



**Figure 2.** (A) Gluteus maximus muscle. (B) Piriform muscle.

## ANATOMIC REFERENCE POINT MARKING

Through dissection of seven fresh and formalinized cadavers and a review of previously published work,[4,5,7-10,13,17,18] we developed the following based on bone reference points that could be fixed and were easily identifiable: sacrum, coccyx, posterior inferior iliac spine, iliac crest, and greater femoral trochanter. We have observed that the lateral limit of the gluteus maximus can be identified by a

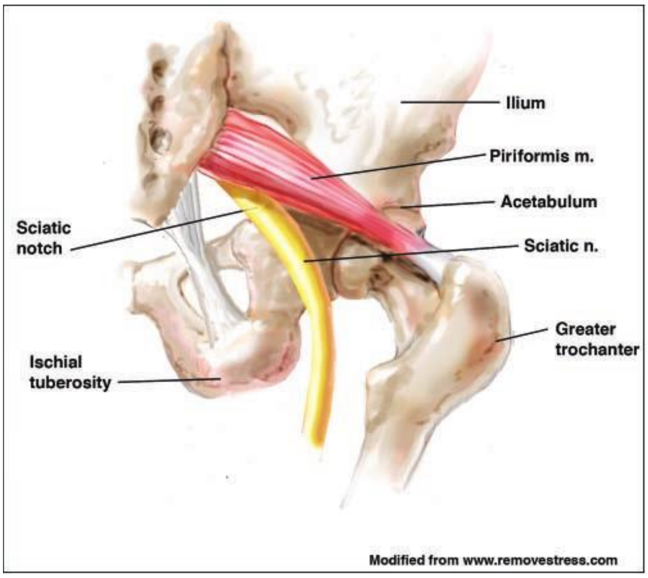



**Figure 3.** Sciatic nerve.

line linking the medial third of the iliac crest and femoral great trochanter. It can be palpated during voluntary contraction (Figure 5). The middle third of the distance between the posterior superior iliac spine and the coccyx corresponds to the upper and lower limits of the piriform muscle (insertion in the femoral great trochanter). The sciatic nerve emerges right below this muscle, at the midline of the thigh at the coccyx level (Figures 5 and 6).

## IMPLANTS

Over the years, different types of implants have been utilized for gluteal augmentation, with either a round or anatomic base and a smooth or textured surface, such as the implants proposed by Hidalgo, Vergara, and De la Peña.[5] We have used cohesive gel gluteal implants with either a spherical or anatomic base (quartz model/ Silimed, Rio de Janeiro, Brazil) and with a smooth surface because of the low risk of capsular contracture with intramuscular placement (Figure 7). We employed photographic analysis to determine the implant size and type that would obtain the best buttocks projection for each case.[7,19,20]

## TECHNIQUE

The subcutaneous layer was infiltrated with 1:200,000 epinephrine solution. A 6-cm skin incision was made positioned within the 5-mm wide zone in the intergluteal groove. Subcutaneous dissection was performed at 45 degrees, thus preserving the sacral ligament and extending to the gluteus maximum muscle aponeurosis. Above this plane, the dissection proceeded along muscle fibers, measuring 6 cm in length.

Through blunt dissection, an intramuscular placement site was opened at a depth of 3 cm and 1 cm wider than the base of the implant, to ensure that the implant would be fully covered by the gluteal maximus muscle, thus avoiding injury to the sciatic nerve that is below and protected by the muscle. The depth of the intramuscular pocket is a critical issue because of the risk of implant herniation and sciatic nerve injury if the dissection is too superficial or too deep, respectively. This dissection was begun cranially to avoid inadvertent rupture of the muscle and subsequent herniation of the implant (Figure 8).

After introducing the implant in the position most suitable for each individual case, such that the implant was covered by the gluteus maximus muscle surface (Figure 9), muscle closure was performed with mononylon 2-0, fascia included. A surgical suture was placed in the subcutaneous detachment, linking it to the fascia of the gluteus maximus muscle so as to avoid seroma. The intergluteal groove was reconstituted with a 3-0 mononylon suture attaching the deep subcutaneous cellular layer to the sacral ligament, followed by a subdermal suture (including the decorticated dermis) and finally an intradermal suture (Figure 10). A video of the author's technique can be found at www.aestheticsurgeryjournal.com.

## POSTOPERATIVE CARE

Patients were advised to rest in the prone position for seven days postoperatively. They were directed to avoid sitting and, if sitting were necessary, to do it by flexing the trunk. The dressing was changed daily and a girdle was kept in place for one month.

We believe that the described technique offers the optimal choice for primary aesthetic augmentation. In some secondary cases and poliomyelitis sequelae, muscle thickness may be insufficient to support the implant, necessitating an alternative technique such as a submuscular or subfascial implant placement.

## RESULTS

Between July 2006 and February 2009, 105 patients received gluteal implants. All patients were female; ages ranged from 22 to 50 years. Follow-up ranged from three months to three years, with an average of one year. During this period, no implant changed position, probably because the intramuscular pocket provided good stability (Figures 11-15). The scar was hidden in the intergluteal fold in all cases. Even in those cases where limited dehiscence occurred, the scar was difficult to see without spreading the buttocks. Before learning to close the dead space, we treated 55 patients and encountered five cases (9.09%) of seroma and three cases (5.45%) of partial dehiscence. After beginning to close the undermined area, we treated 50 patients, encountering only one case (2%) seroma and no cases of dehiscence. Wound dehiscence secondary to seromas was

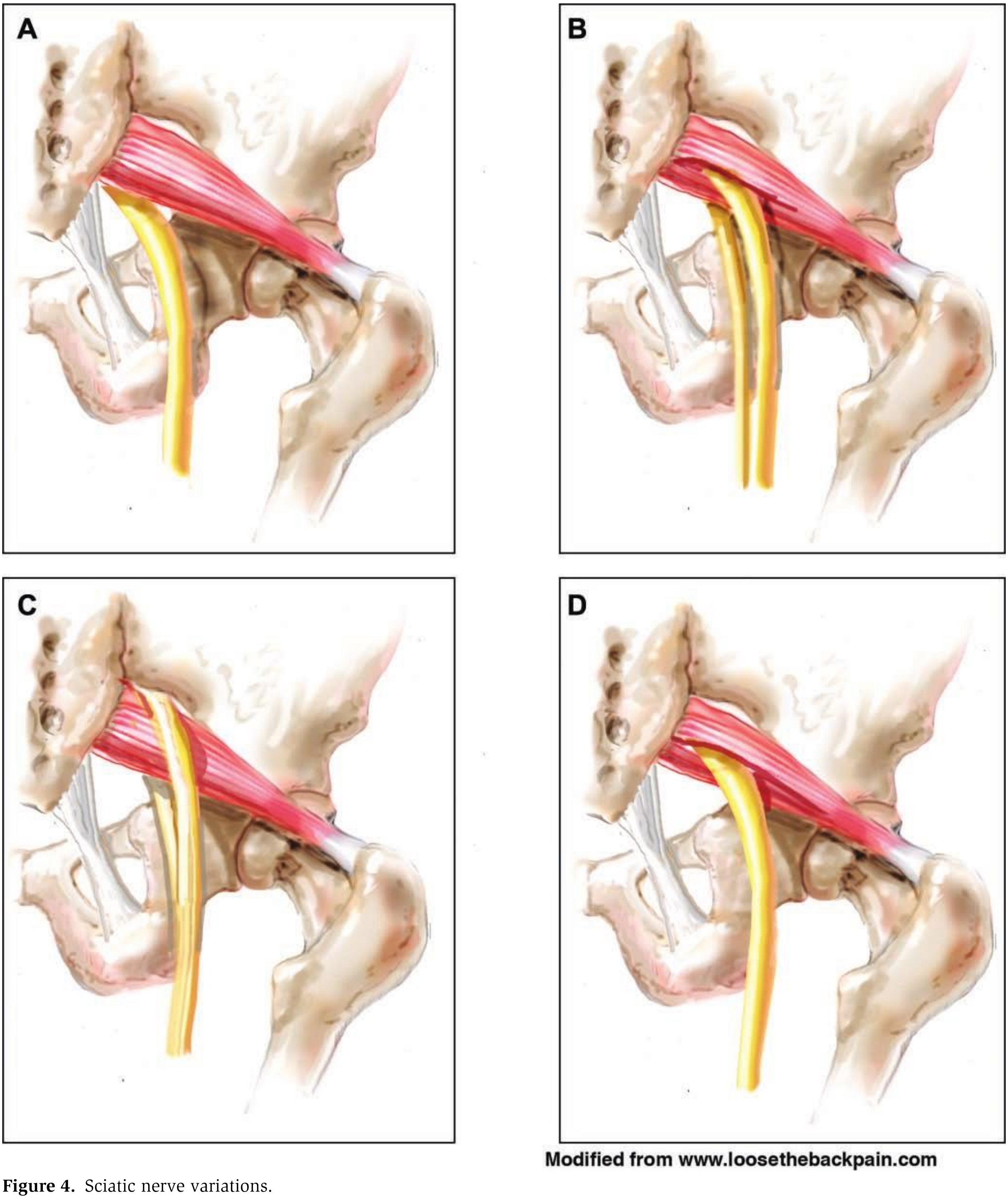



**Figure 4.** Sciatic nerve variations.

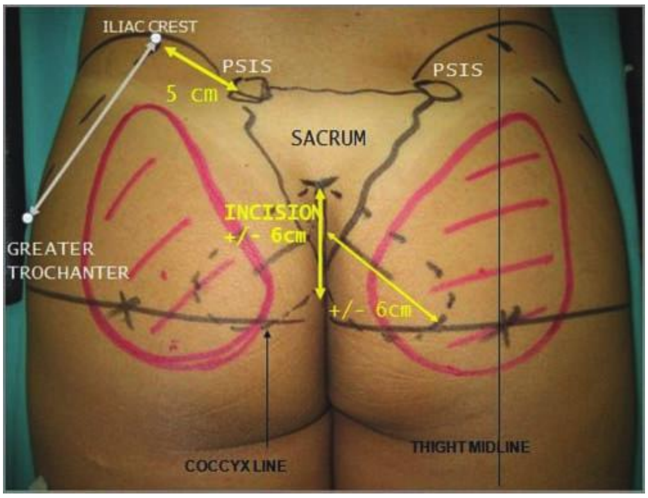



**Figure 5.** Marking of anatomic reference points. PSIS, posterior superior iliac spine.

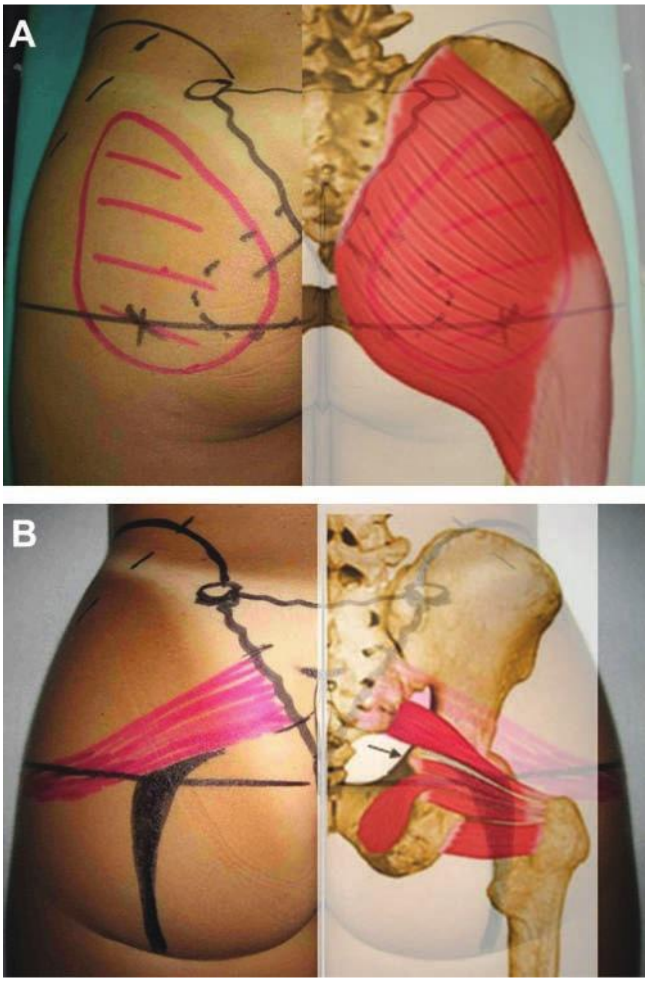



**Figure 6.** (A) Superimposed anatomical figure. (B) Piriform muscle and sciatic nerve illustration.

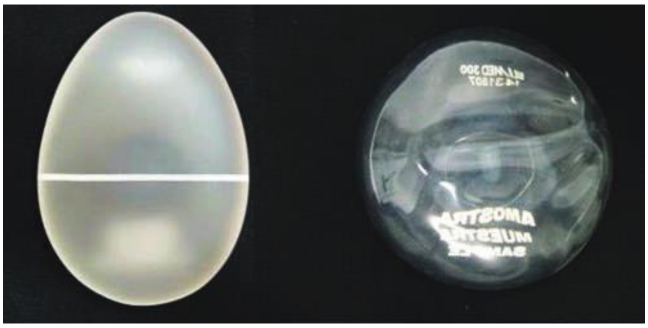


**Figure 7.** Gluteal implants: anatomic (quartzo) (*left*); round (*right*).

conservatively treated without sequelae and with good aesthetic results. Wound infection occurred in one case (0.9%), but it was unrelated to other complications, did not affect muscle, and was treated on an outpatient basis with good results. Bruising on the side of the thigh was encountered in four cases (3.8%). There were no postoperative hematomas.

## DISCUSSION

Although implant gluteoplasty is now a frequently performed procedure, it still meets some resistance from surgeons and patients because of poor results in the past, such as an unnatural appearance and ptosis. With our technique, we were able to achieve a natural appearance and pleasing aesthetic results with intramuscular implantation.[9,17,18,21] This technique has replaced submuscular placement[10] in our own practice. With submuscular placement, the implants should not exceed the lower limit of the piriform muscle,[6,10,22,23] but with the intramuscular technique, it is possible to exceed this limit because the sciatic nerve is well protected by a thick layer of gluteal muscle. We can thereby achieve a better contour to the buttocks.[24] The gluteal fascia is a thin structure, especially at the center of the muscle surface, as was quite noticeable in our dissection. Despite our lack of experience with the subfascial technique, we believe that if this technique is employed, a palpable or visible implant could result, as could ptosis, especially in the long term.[19,22,25,26] We do not employ subcutaneous placement because laxity resulting from the superficial fascia system incision leads to ptosis, visible margins, and displacement of the implant.[6,22,27,28]

Some authors associate wound dehiscence with placement of larger implants.[22] In our series, this complication always occurred after development of seromas. We consider the preservation of sacral ligament as described previously[18] to be a major advance, in that it isolates each operated side and hides the scar. Some authors also

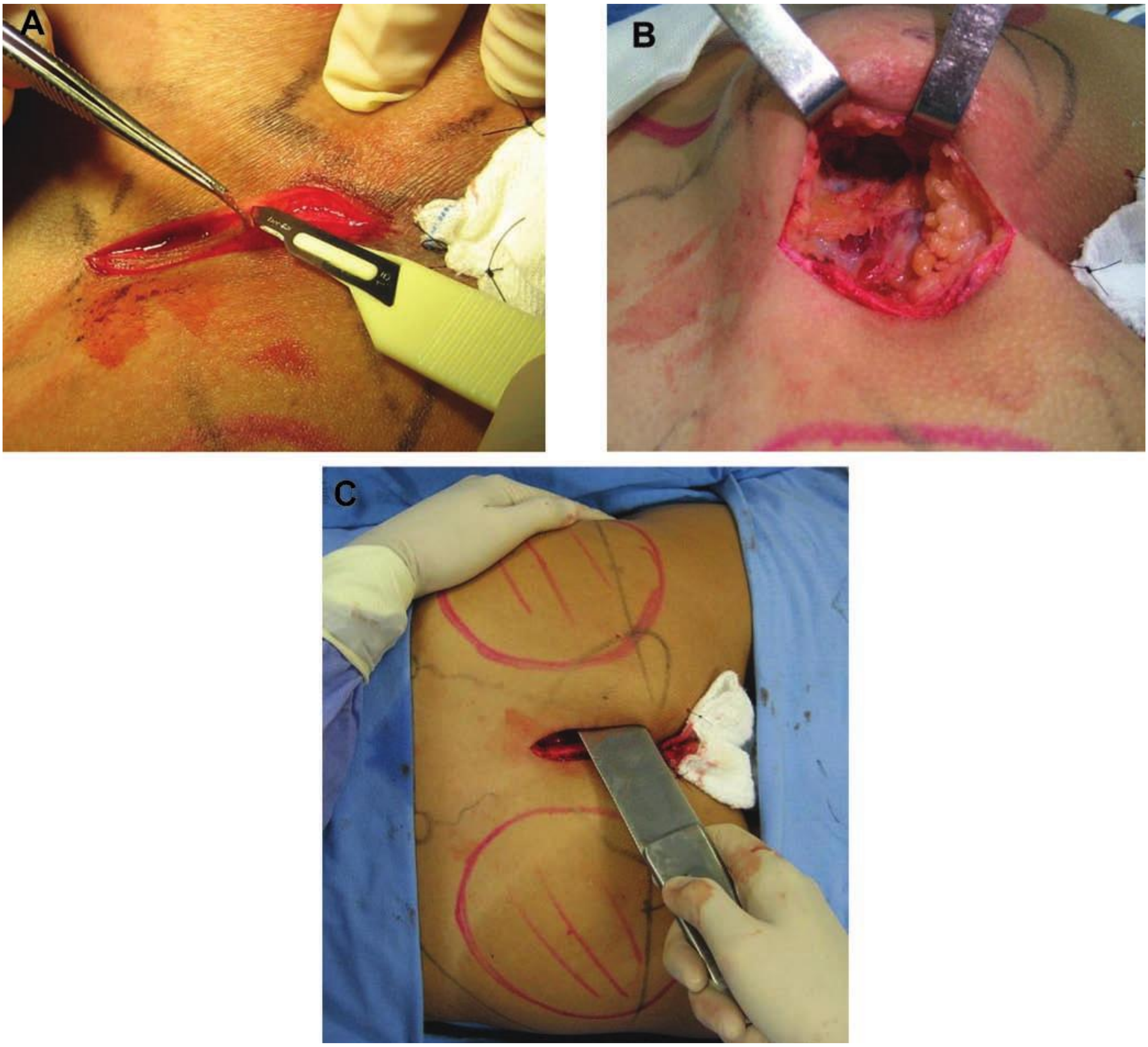



**Figure 8.** (A) Decortication. (B) Subcutaneous detachment. (C) Intramuscular blunt dissection.

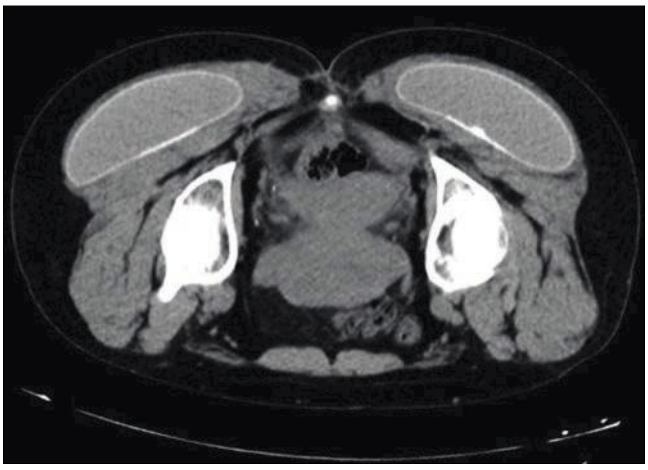


**Figure 9.** Computed tomography scan showing the implant completely covered by muscle.

employ closed-drainage aspiration.[7,17,18,24] We elect not to do so because we believe that muscle tissue has a high absorption capacity; furthermore, there was no dead space left after suturing the subcutaneous detachment. There were no instances of hematoma in our series and we achieved seroma resolution from the closure of the subcutaneous detachment.

## CONCLUSIONS

The study of various surgical techniques employed in the past—not always successfully—to increase augment the gluteal region, as well the results of a cadaver dissection study, allowed us to develop a surgical technique based on fixed and easily identifiable anatomic reference points. This technique provides safer surgery and more reproducible and predictable results with negligible complication rates.

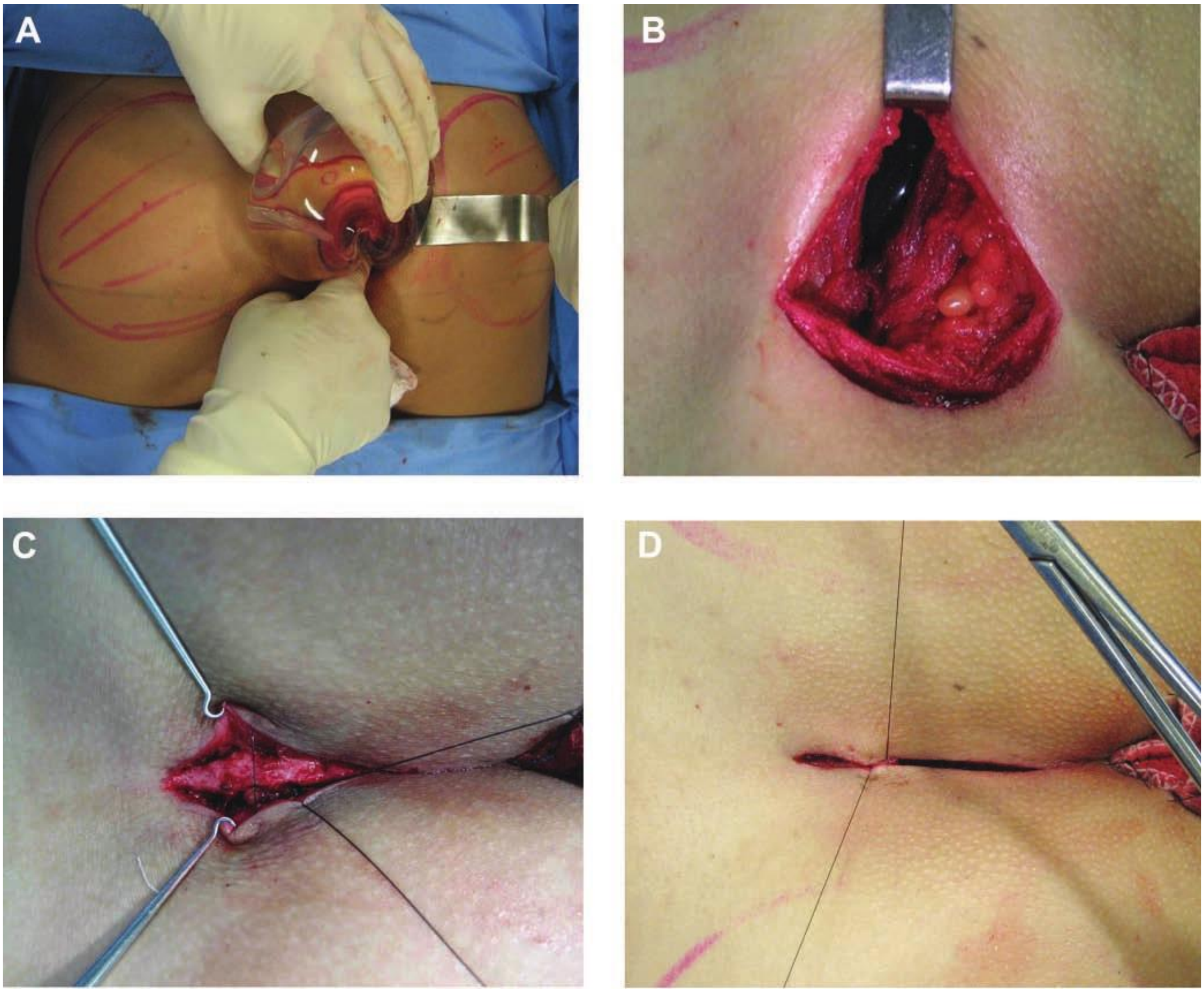


**Figure 10.** (A, B) Implant insertion. (C, D) Subdermal suture, including the decorticated dermis.

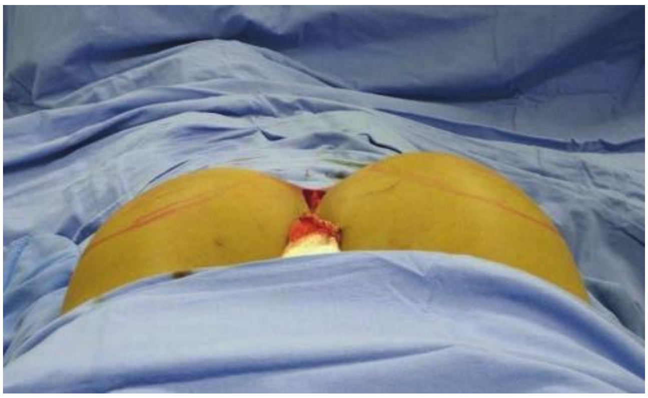


**Figure 11.** Implant in the right side.

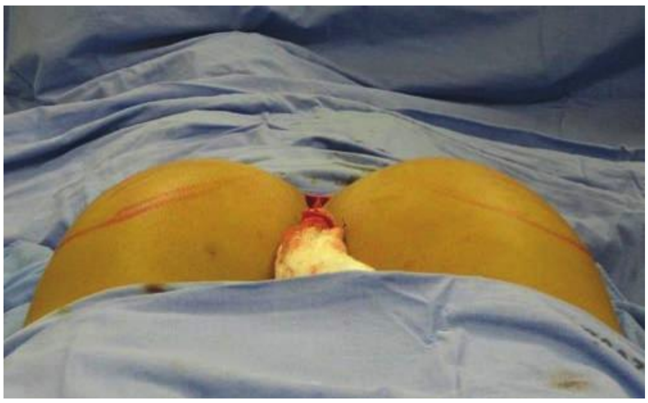


**Figure 12.** Both implants introduced.

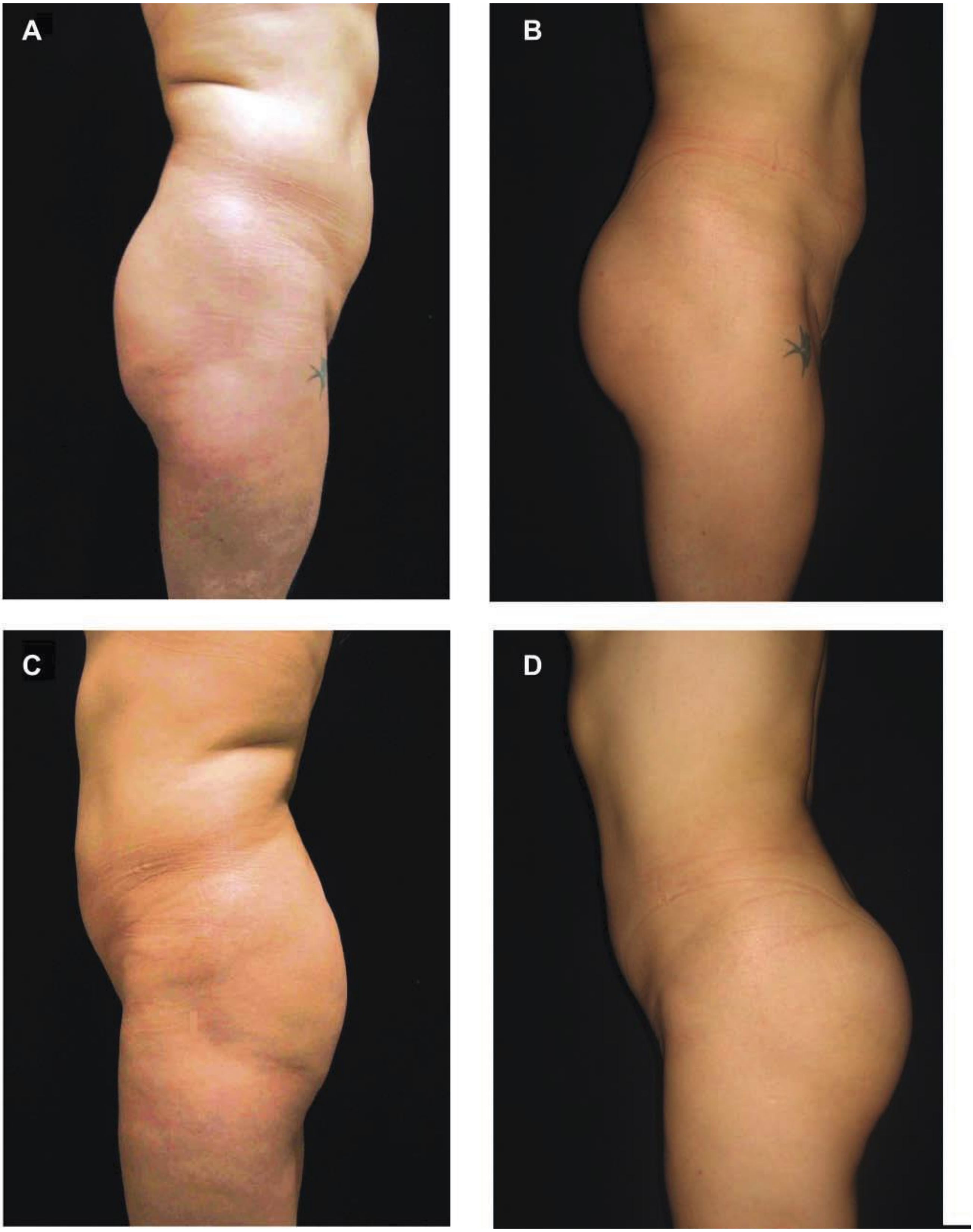



**Figure 13.** (A-C) Preoperative views of a 44-year-old woman whose main complaint was of lack of projection. (B-D) One year after placement of 300-mL anatomical base implants.

*Figure continued on next page.*

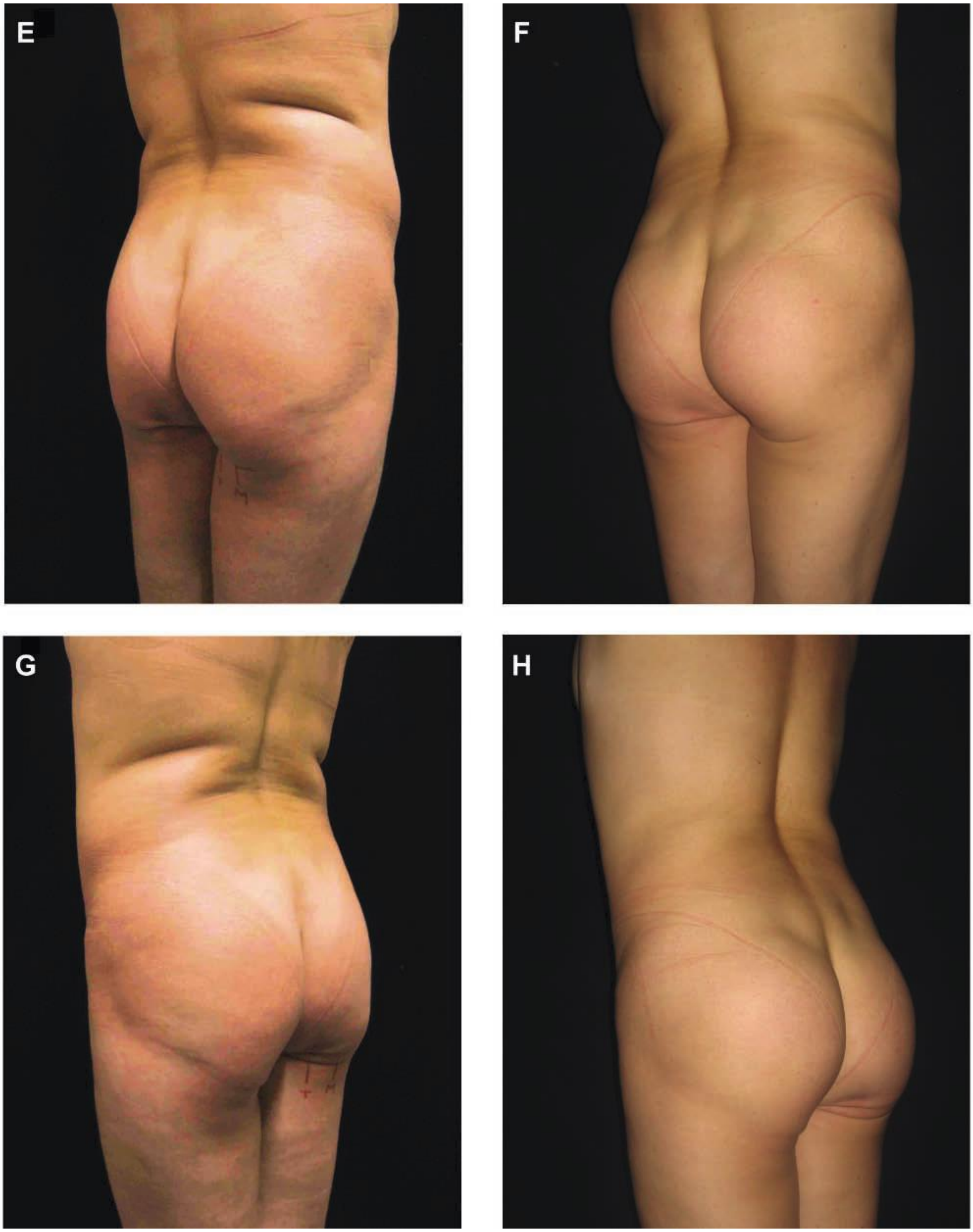



**Figure 13 (continued)** (E, G) Preoperative views of a 44-year-old woman whose main complaint was lack of projection. (F, H) One year after placement of 300-mL anatomical base implants.

*Figure continued on next page.*

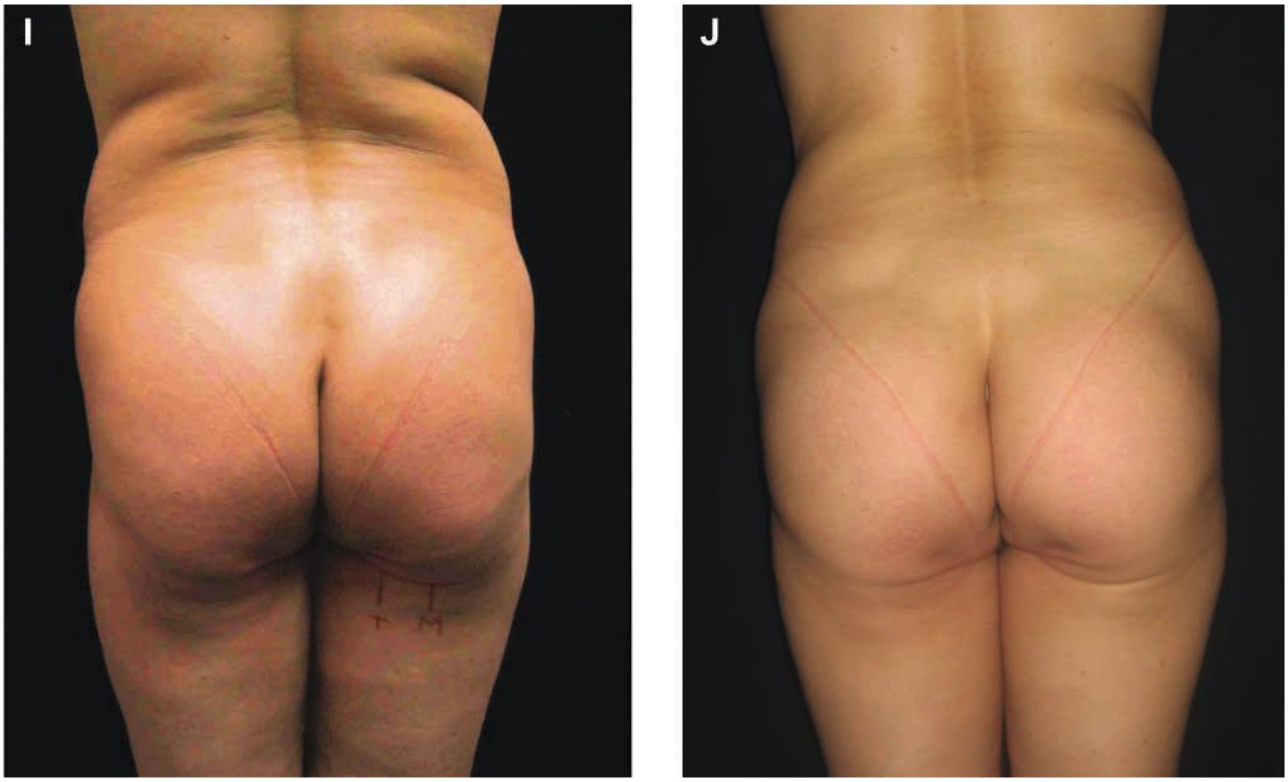



**Figure 13 (continued).** (I) Preoperative views of a 44-year-old woman whose main complaint was lack of projection. (J) One year after placement of 300-mL anatomical base implants.

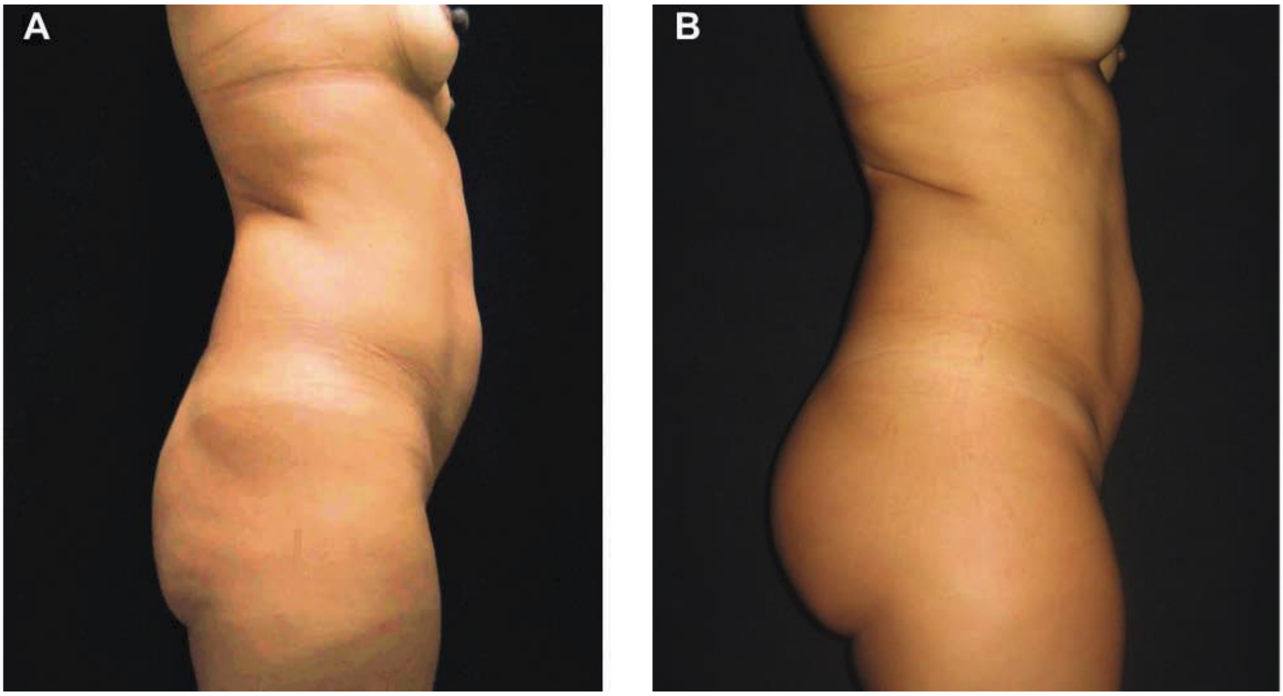



**Figure 14.** (A) Preoperative views of a 44-year-old woman whose main complaint was lack of projection. (B) One year after placement of 300-mL round base implants.

*Figure continued on next page.*

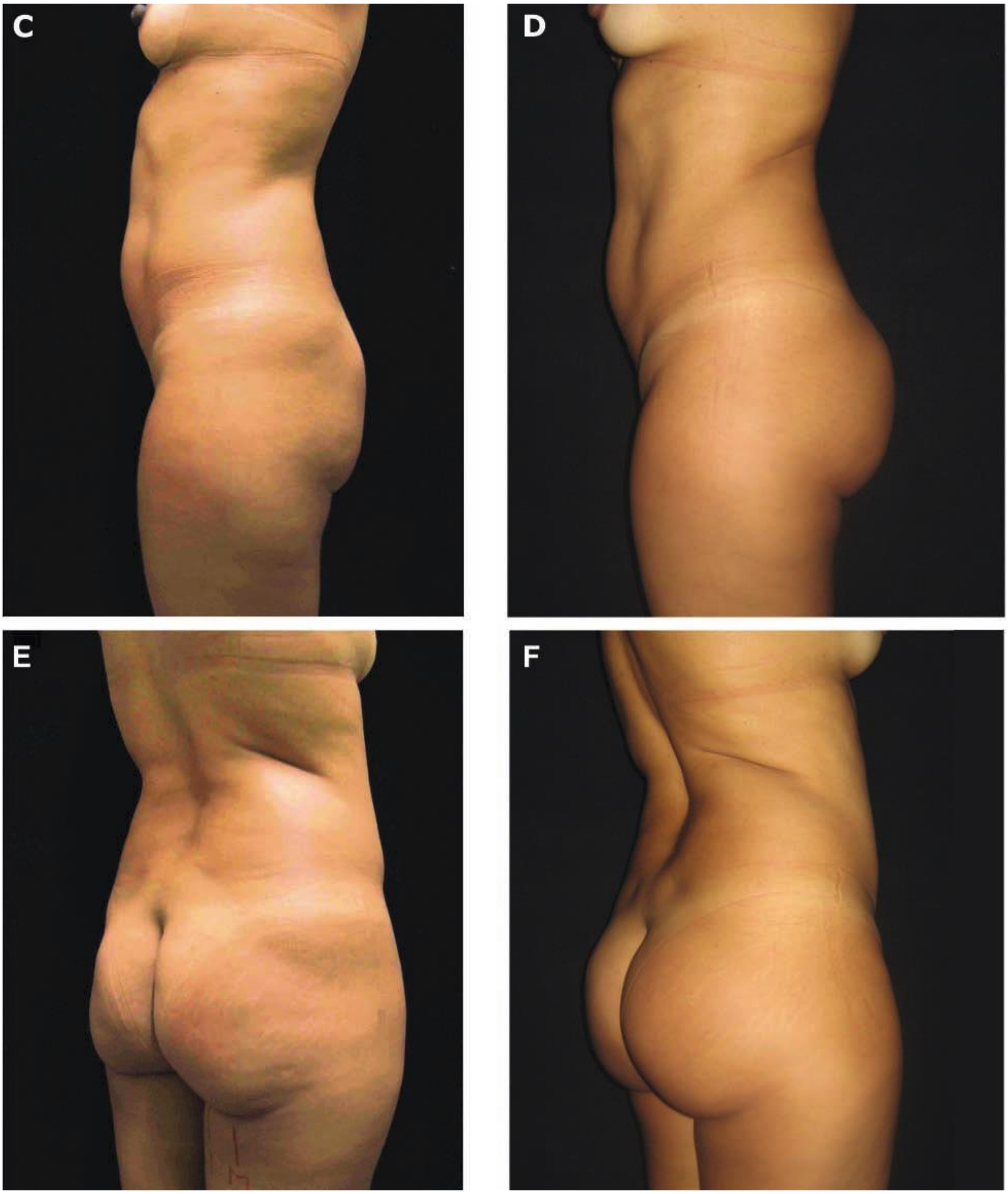



**Figure 14 (continued).** (C, E) Preoperative views of a 44-year-old woman whose main complaint was lack of projection. (D, F) One year after placement of 300-mL round base implants.

*Figure continued on next page.*

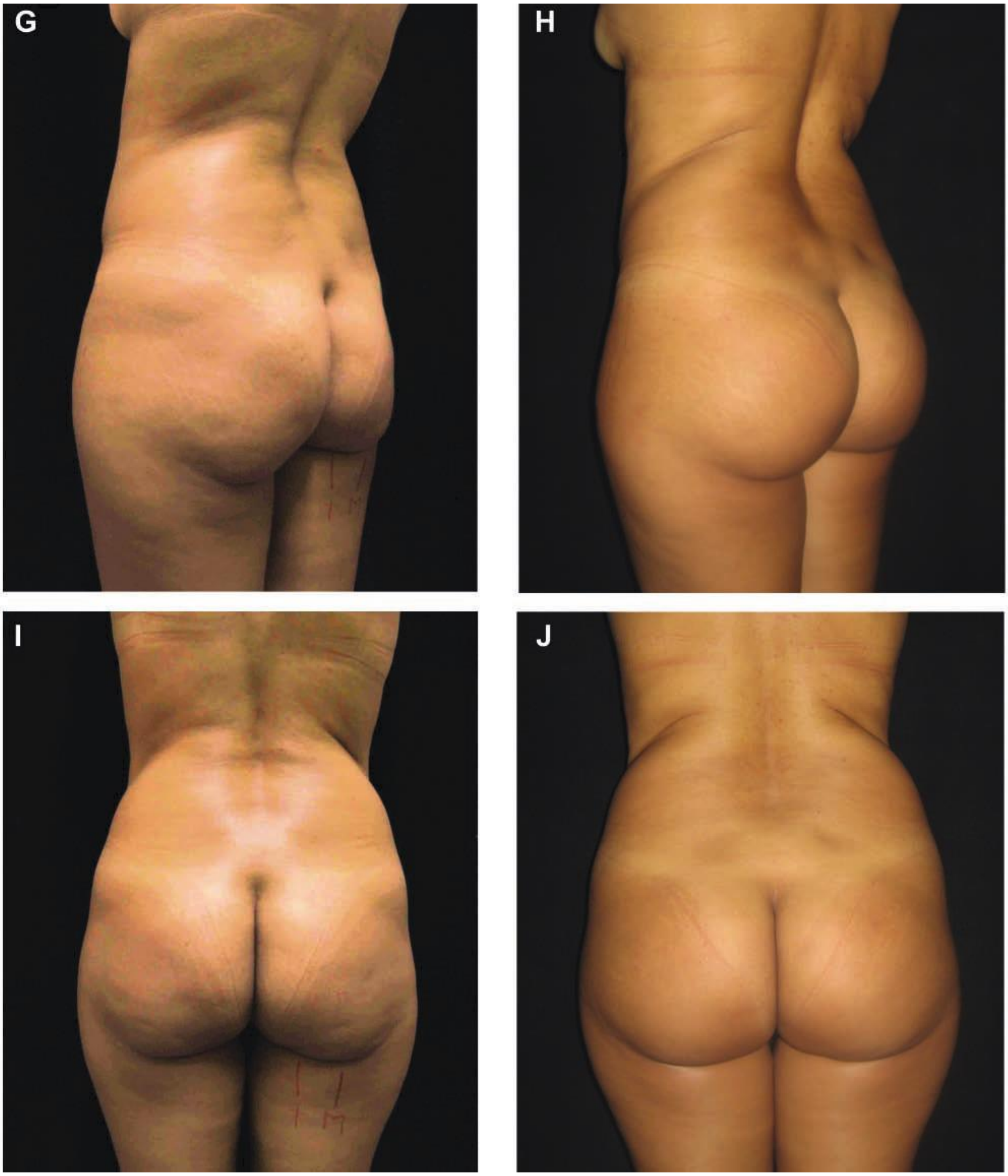



**Figure 14 (continued).** (G, I) Preoperative views of a 44-year-old woman whose main complaint was lack of projection. (H, J) One year after placement of 300-mL round base implants.

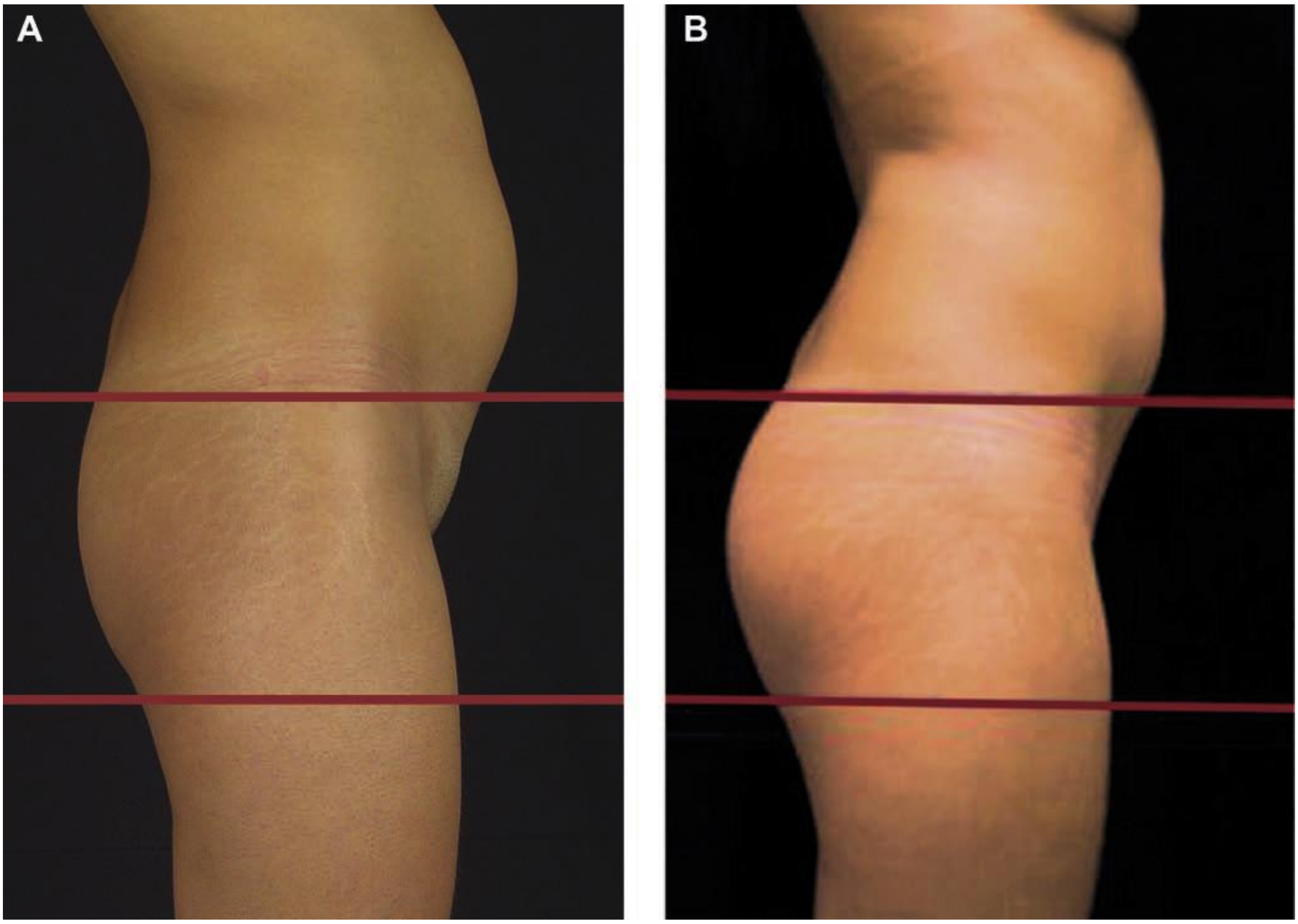



**Figure 15.** (A) Preoperative view of a 50-year-old patient whose main complaint was lack of projection. (B) Three months after placement of 300-mL anatomic base implants.

## Disclosures

The authors declared no conflicts of interests with respect to the authorship and/or publication of this article.

## Funding

The authors received no financial support for the research and/or authorship of this article.

## REFERENCES

1. Bartels RJ, O'Malley JE, Douglas WM, Wilson RG. Unusual use of the Cronin breast prothesis. *Plast Reconstr Surg* 1969;44:500.
2. Cocke WM, Ricketson G. Gluteal augmentation. *Plast Reconstr Surg* 1973;52:93.
3. De La Peña JA, Rubio OV, Cano JP, Cedillo MC, Garces MT. History of gluteal augmentation. *Clin Plastic Surg* 2006;33:307-319.
4. González-Ulloa M. Gluteoplasty: a ten-year report. *Aesthetic Plast Surg* 1991;15:85-91.
5. Mendieta CG. Gluteoplasty. *Aesthetic Surg J* 2003;23:441-455.
6. Nahai F. *The Art of Aesthetic Surgery: Principles and Techniques*. St. Louis, MO: Quality Medical Publishing; 2005.
7. Melega JM. *Cirurgia Plástica Fundamentos e Arte—Cirurgia Estética*. Rio de Janeiro: Medsi; 2003.
8. De La Peña JA, Monjardin LH, Gamboa LF. Augmentation gluteoplasty: anatomical and clinical considerations. *Plast Cosmet Surg* 2000;17:1-12.
9. Vergara R, Marcos M. Intramuscular gluteal implants. *Aesthetic Plast Surg* 1996;20:259-262.
10. Robles JM, Tagllapertra JC, Grandl YMA. Gluteoplastia de aumento: Implante submuscular. *Cir Plástica Iberolatinoamericana* 1984;10:365-375.
11. Centeno RF, Young VL. Clinical anatomy in aesthetic gluteal body contouring surgery. *Clin Plastic Surg* 2006;33:347-358.
12. Gardner E, Gray DJ, O'Rahilly R. *Anatomia—Estudo regional do corpo humano*. 4th ed. Rio de Janeiro: Guanabara Koogan; 1988.
13. Mathes SJ. *Plastic Surgery*. 2nd ed. Philadelphia: Elsevier; 2006.
14. Mathes SJ, Nahai F. Classification of the vascular anatomy of muscles: experimental and clinical correlation. *Plast Reconstr Surg* 1981;67:177-187.

15. Testut L, Latarjet A. *Tratado de Anatomia Humana*. 8th ed. Barcelona: Salvat; 1929.
16. Williamns PL, Warnick R, Dyson M, Bannister LH. *Gray Anantomia Humana*. 37th ed. Rio de Janeiro: Guanabara Koogan; 1995.
17. Camarena LG, Paillet JC. Combined gluteoplasty: lipossuction and gluteal implants. *Plast Reconstr Surg* 1999;104:1524-1531.
18. Gonzales R. Augmentation gluteoplasty: the XYZ method. *Aesthetic Plast Surg* 2004;28:417-425.
19. Aiache A. Gluteal recontouring with combination treatments: implants, liposuction, and fat transfer. *Clin Plast Surg* 2006;33:295-403.
20. Guerra RC, Quezad J. What makes buttocks beautiful? A review and classification of the determinants to achieve them. *Aesthetic Plast Surg* 2004;28:340-347.
21. Ruiz JB, Fontdevila J, Manzano M, Renom SJM. Hip and buttock implants to enhance the feminine contour for patients with HIV. *Aesthetic Plast Surg* 2006;30:98-103.
22. Bruner TW, Roberts TL, Nguyen K. Complications of buttocks augmentation: diagnosis, management, and prevention. *Clin Plast Surg* 2006;33:449-466.
23. Hidalgo JE. Submuscular gluteal augmentation: 17 years of experience with gel and elastomer silicone implants. *Clin Plast Surg* 2006;33:438-447.
24. Mendieta C. Intramuscular gluteal augmentation technique. *Clin Plast Surg* 2006;33:423-434.
25. Gonzales R. *Buttocks Reshaping*. Rio de Janeiro: Indexa; 2006.
26. Roberts TL, Weinfeld AB, Bruner TW, Nguyen K. "Universal" and ethnic ideals of beautiful buttocks are best obtained by autologous micro fat grafting and liposuction. *Clin Plast Surg* 2006;33:371-394.
27. Lockwood TE. Superficial fascia system (SFS) of the trunk and extremities: a new concept. *Plast Reconstr Surg* 1991;87:1009-1018.
28. Song AY, Askari M, Azemi E, et al. Biomechamical properties of the superficial fascia system. *Aesthetic Surg J* 2006;26:395-403.

**APÊNDICE C-** Reducing wound complications in gluteal augmentation surgery - Segundo artigo publicado

COSMETIC

# Reducing Wound Complications in Gluteal Augmentation Surgery

Fernando Serra, M.D.
José Horácio Aboudib, M.D.
Ruy Garcia Marques, M.D., Ph.D.

*Rio de Janeiro, Brazil*

**Background:** Over the past 30 years, many techniques have been proposed for gluteal augmentation with implants. The intramuscular technique provided greatly improved results and a consequent increase in the number of such procedures performed in Brazil. However, the data available in the medical literature reveal high rates of wound complications, mostly seroma and dehiscence. The aim of this study was to present changes in the management of the wound of augmentation gluteoplasty with silicone implants in an attempt to reduce the rates of postoperative complications.

**Methods:** Twenty female candidates for augmentation gluteoplasty were selected prospectively and submitted to the procedure with a modified technique. The incidence of wound complications was compared with the data of the authors and of the literature.

**Results:** In the comparison between homogeneous groups of patients, the modified technique reduced the rate of wound complications from 35 percent to 5 percent. The most frequent complications were seroma and dehiscence. The combination of liposuction of the flanks was not a risk factor for the occurrence of these complications.

**Conclusions:** Reduction of the undermined subcutaneous area, application of adhesion stitches, and maintenance of good vascularization in the sacral region are the keystones of the authors' proposal. The modifications of the technique presented here are simple and easy to perform, and have proved effective in reducing complications during augmentation gluteoplasty with silicone implants. (*Plast. Reconstr. Surg.* 130: 706e, 2012.)

**CLINICAL QUESTION/LEVEL OF EVIDENCE:** Therapeutic, II.

Historically, since 1969, many implants have been used in the gluteal region, when Bartels et al.[1] described the use of breast implants of Cronin for the reconstruction of gluteal idiopathic atrophy. The procedure for aesthetic purposes has gained strength since the 1970s, after the description of the use of implants in the gluteus by Cocke and Ricketson[2] and the dissemination of technical enhancements by González-Ulloa,[3] and the development of specific implants in this area. Since then, several techniques have been proposed,[4–12] especially for the dissection plane for the introduction of the implant, such as the subcutaneous plane by González-Ulloa,[3] the subfascial plane by de La Peña et al.,[4] the submuscular plane by Robles et al.,[7] and the intramuscular plane by Vergara and Marcos.[8]

*From the Plastic Surgery Service and the Department of General Surgery, Pedro Ernesto University Hospital, Rio de Janeiro State University.*
*Received for publication April 14, 2012; accepted May 18, 2012.*

DOI: 10.1097/PRS.0b013e318267d716

Currently, the intramuscular technique has greater acceptance among surgeons,[5,8–10,12–14] but some of them show uncertainty about the operation because of the high potential for wound complications, such as infection, hematoma, seroma (defined as a characteristically exudative collection formed deep in the dermis),[15] and dehiscence, reported in up to 30 percent of cases.[16,17] The objective of the present study was to show small changes in the surgical technique of intramuscular gluteoplasty with implants and to demonstrate that these simple changes can reduce the rates of wound complications when compared with the classic technique.

## PATIENTS AND METHODS

This study was approved by the Research Ethics Committee of Hospital Universitário Pedro Er-

**Disclosure:** *None of the authors has a financial interest or commercial association with any of the subject matter or products mentioned in this article.*

nesto. All patients signed an informed consent form. The study subjects were selected prospectively by order of attendance, provided that they met the inclusion criteria.

Twenty patients scheduled for gluteoplasty with gluteal implants underwent the operation with the modified intramuscular technique from July of 2010 to March of 2011 (group A). Retrospectively, we analyzed the last 20 patients submitted to intramuscular gluteoplasty with the classic technique, which included the period from June to December of 2008 (group B). Between January of 2009 and June of 2010, the authors developed the proposed technical amendments. All patients were operated on by the first author (F.S.) of this study. Inclusion criteria included female sex; age between 20 and 51 years; body mass index between 18 and 27 kg/m$^2$ (Table 1); and anthropometric analysis type II, III, or IV, according to Cuenca-Guerra and Quezada[18] (Table 2). Exclusion criteria included smoking, chronic diseases such as diabetes, systemic arterial hypertension and cancer, excess perigluteal fat, true gluteal ptosis, and senile gluteus.

**Table 2. Cuenca-Guerra and Quezada's Anthropometric Classification***

| Type | Description |
|---|---|
| I | Perigluteal fat excess |
| II | Appropriate gluteal volume<br>Absence of gluteal projection |
| III | Absence of gluteal volume, appropriate gluteal projection resulting from lumbar hyperlordosis |
| IV | Absence of gluteal volume, absence of gluteal projections |
| V | Senile gluteus |

*From Cuenca-Guerra R, Quezada J. What makes buttocks beautiful? A review and classification of the determinants of gluteal beauty and the surgical techniques to achieve them. *Aesthetic Plast Surg.* 2004; 28:340–347.

## Description of the Techniques

All patients underwent spinal anesthesia conduction block, according to the anesthesiologist's choice.

**Classic Intramuscular Gluteoplasty**

Through a 6 × 5-mm fuse incision positioned in the intergluteal groove, a subcutaneous dissection is performed at 45 degrees, laterally, until the fascia of the maximus gluteus muscle, preserving a skin-fat island in the midline (sacrocutaneous ligament) to be deepithelialized.[8,9,12] The detachment of the subcutaneous layer from the gluteus maximus fascia extended 6 cm in length and 6 cm in width following the direction of its fibers (Fig. 1). This area has been previously infiltrated with 1:200,000 epinephrine solution. By blunt dissection, a 2- to 2.5-cm deep intramuscular pocket is made, exceeding by 2 to 3 cm the size of the base implant. A sterile compress soaked in saline solution with 0.9% epinephrine at a concentration of 1:200,000 is introduced to help with hemostasis. The same is done in the contralateral dissection.

After removing the compress, the implant is introduced into the pocket so that it is covered by the gluteus maximus muscle across its entire surface. The muscle synthesis is performed with 2-0 monofilament nylon, including its fascia.

Closure of the wound starts with the synthesis of the deep subcutaneous to the sacral ligament with 3-0 monofilament nylon, followed by subdermal suture with 4-0 monofilament nylon, including the decorticated dermis, and finally, intradermal suture with 4-0 poliglecaprone (Monocryl; Ethicon, Inc., Somerville, N.J.). This technique was applied to the patients of group B.

**Modified Intramuscular Gluteoplasty**

The subcutaneous dissection is performed in a meticulous manner so that the skin-fat island preserved in the midline will have at least a 3-cm-wide base attached to the sacrum bone, regardless of the inclination of its dissection (Fig. 2). It will preserve the sacral ligament and guarantee good vascular supply to this tissue. The dimensions of the undermining above the fascia should be reduced to the minimum necessary for their incision and introduction of the implant, approximately 5 × 2 cm (Figs. 3 and 4). During the synthesis, adhesion stitches are applied, joining the subcutaneous layer to the fascia with 4-0 monofilament nylon (Fig. 5), similar to that described by Baroudi and Ferreira.[19] The distance between the stitches is no more than 2 cm, closing the entire undermining of the subcutaneous area.

In the deep subcutaneous sutures to the sacral ligament (skin-fat island), it is essential that such

**Table 1. Patient Characteristics for Groups A and B***

| | No. of Patients | Age (yr) | Body Mass Index (kg/m$^2$) | Implant Volume (ml) |
|---|---|---|---|---|
| Group A | 20 | 32.9 (20–47) | 21.78 (18.0–26.5) | 360 (350–400) |
| Group B | 20 | 37.35 (22–51) | 22.03 (19.2–27.7) | 298.5 (270–300) |
| $p$ | | 0.10 | 0.71 | 0.0001 |

*Values are presented as average (range).

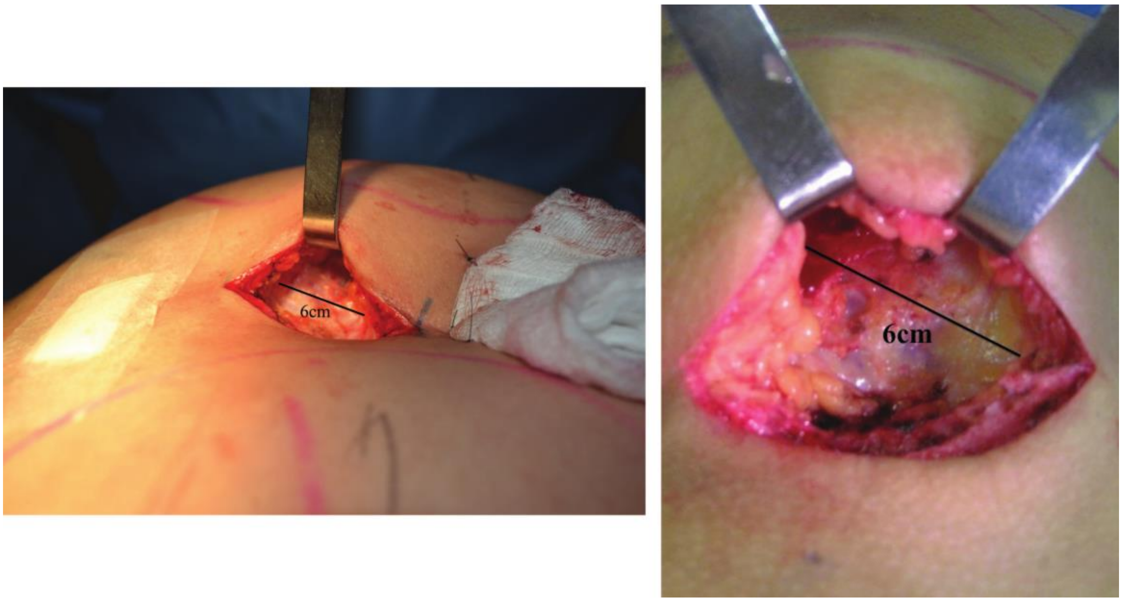



**Fig. 1.** (*Left*) Classic technique of subcutaneous detachment above the gluteus maximus fascia (width, 6 cm). (*Right*) Close-up of the classic technique of subcutaneous undermining (compare with modified technique shown in Fig. 3).

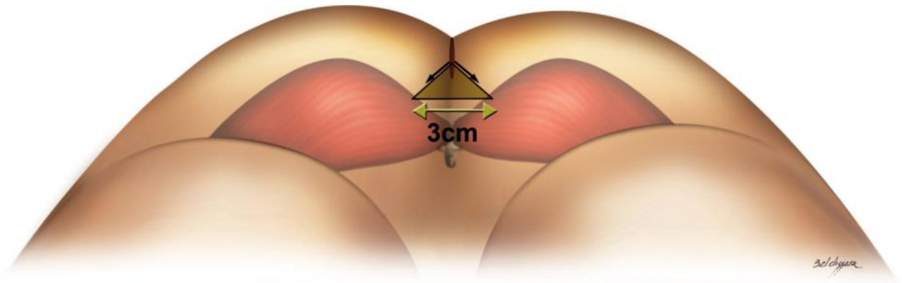



**Fig. 2.** Cutaneous incision and midline dermal fat island dissection. It is important to preserve at least a 3-cm base attached to the sacrum bone.

suture be tangential to the tissue of the skin-fat island; otherwise, the suture will advance toward the midline, causing tissue ischemia (Fig. 6). Simple stitches with 5-0 monofilament nylon are used in the skin. The other operative times are identical to those of the classic technique. This technique was applied to the patients of group A.

### Postoperative Care

Patients were advised to rest in the prone position for 24 hours. The day after the operation, they could sit down and be discharged. The dressing was changed daily and the stitches were removed after 14 days. A girdle was kept in place for 1 month in all patients of this study.

The incidence of wound complications, such as seroma, dehiscence, hematoma, and infection, was compared between the two study groups. A seroma was considered to be the output of serous or serous bloody secretion through the operative wound for 3 or more days. A hematoma was diagnosed in patients who presented bloody collection in the subcutaneous tissue, and infection was defined by clinical criteria of pain, heat, redness, and purulent secretion in the operative wound.

### Implants

Gluteal cohesive gel implants with spherical or anatomical bases were used (Silimed Quartzo, Silimed Ind Implantes LTDA, Rio de Janeiro, Brazil), both with a smooth surface.

### Statistical Analysis

Parametric tests (*t* test) were used for the comparisons of body mass index, age, and operative time between groups A and B. The presence of wound complications in the independent groups A and B was treated as a dichotomous categorical

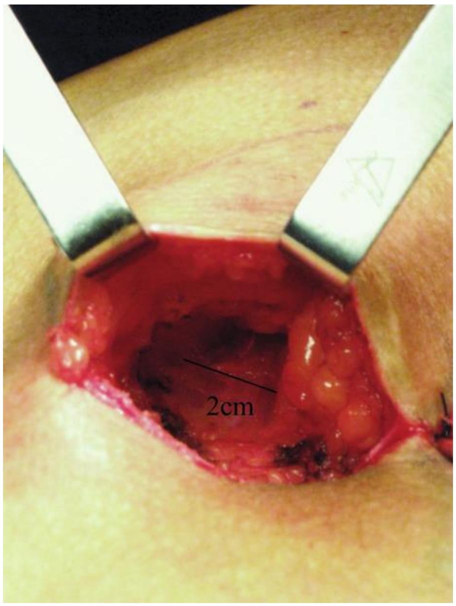



**Fig. 3.** Modified technique of subcutaneous undermining above the gluteus maximus fascia (approximately 2 cm in width).

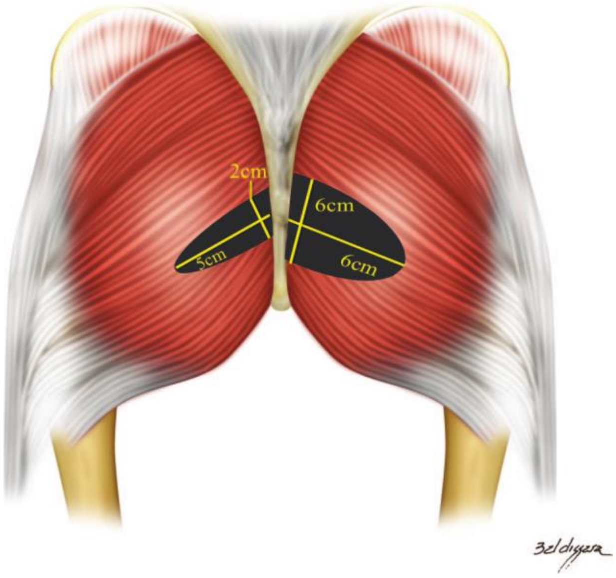



**Fig. 4.** Subcutaneous undermining. (*Left*) Modified technique; (*right*) classic technique.

variable. The Fisher's exact test (nonparametric) was used to compare this variable between groups. The level of significance was set at 0.05 percent in all tests.

## RESULTS

There was no difference between groups regarding age, body mass index, or implant volume (Table 2). Mean operative time was 82.1 minutes with the classic technique (group B) and 86.25 minutes with the modified technique (group A), with no difference between groups ($p$ = 0.403).

In group A, 17 of 20 patients (85 percent) underwent associated flank liposuction, without decubitus change. In group B, there was no associated procedure.

Wound complications such as seroma, hematoma, dehiscence, and infection were found in one of 20 patients (5 percent) in group A and in seven of 20 patients (35 percent) in group B ($p$ = 0.043). The wound complication in group A was seroma. In group B, there were three cases of dehiscence, two seromas, one hematoma, and one infection. The good appearance of the scar in postoperative results of different patients and at different postoperative times is shown in Figures 7 through 9.

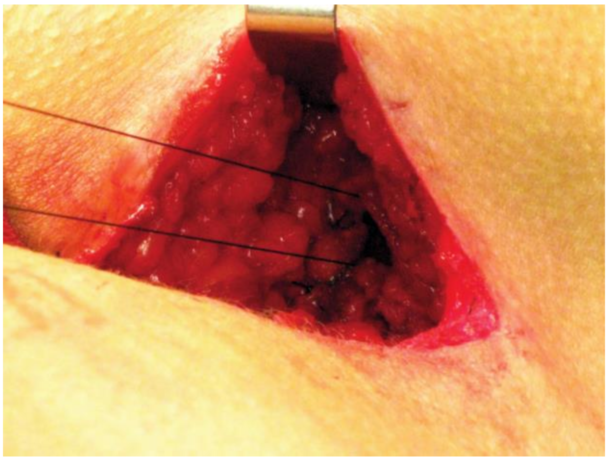


**Fig. 5.** Adhesion stitches addressing the subcutaneous layer and gluteal fascia.

## DISCUSSION

The intramuscular technique for the introduction of gluteal implants offered marked improvement of the results, making them more natural and reducing the risk of sciatic nerve injury and other complications involving this nerve.[8–10,12] In our opinion, this technical change and the consequent improvement of the results were largely responsible for the increase in implant sales and therefore in the number of procedures performed, approximately 20 percent per year over the past 3 years and 42 percent in 2011 in Brazil (according to the sales report of the manufacturer). Currently, this operation is available to the plastic surgeon, and was uncommon at the beginning of the use of specific gluteal implants performed by González-Ulloa in 1977.[3,4]

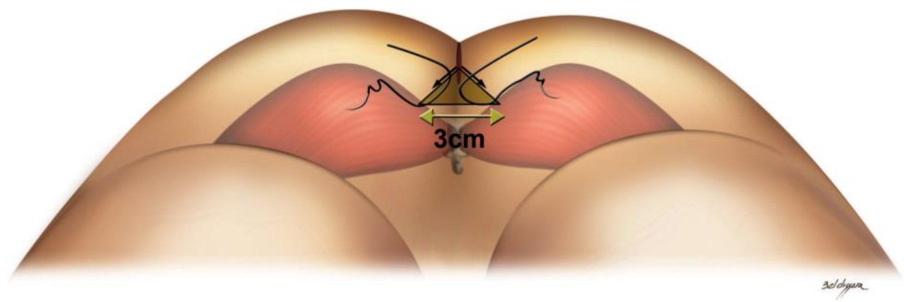



**Fig. 6.** Dermal fat island suture. Avoid stretching the suture up to the midline.

Despite this important technical development, the incidence of wound complications, such as seroma, hematoma, dehiscence, and infection, remains high. Bruner et al. reported this incidence in the main published series, with values ranging from 4 to 30 percent of cases.[16] Gonzales described the preservation of the skin-fat island in the midline,[9] which we consider of great importance, but with a 14 percent rate of occurrence of small dehiscences. Mendieta[10] mentioned wound dehiscence as the greatest frustration with intramuscular gluteoplasty, affecting 30 to 40 percent of patients.

Although the group operated on in this study with the classic technique is retrospective, our data are entirely consistent with the literature when using this technique.[9,10,16] This group participated in another investigation in the same way, with similar inclusion and exclusion criteria.[12] Statistical analysis showed no differences between groups A and B, making them comparable.

Liposuction, when combined (85 percent in group A), did not generate an increase in wound complications, as demonstrated by Rodrigues et al.[20] The operative time did not differ significantly between the two techniques, despite the introduction of adhesion stitches.

The literature is not clear regarding the description of seroma. Gonzales[9] clearly described one case of seroma in the implant pocket. Frequently, such collections are superficial, below the dermis,[15] coming from the detachment of subcutaneous tissue. The modified technique reduced the shearing forces at the interface between the surgical planes once there was less detachment of the subcutaneous layer from the gluteal fascia, and the placement of adhesion stitches. This is believed to prevent seroma.[20,21]

Literature reports show that the midline in the sacral region is a poor territory in terms of perforating vessels[22,23]; thus, the tissue contained in the skin-fat island is fragile in vascular terms. We believe that the large number of reported wound dehiscences and secretions is attributable in part to the ischemia of the skin-fat island which, because of its small size and lack of large-caliber arteries, may have easily reduced its base during subcutaneous dissection, with impairment of vascularization. In addition, the suture of subcutaneous tissue can progress toward the midline and, being done bilaterally, it compromises its vascular pedicle (Fig. 5). We consider that another factor responsible for the lower complication rate in the modified technique is preservation of a well-vascularized tissue in the midline because it is wider than in the classic technique; otherwise, this tissue can become ischemic, leading to lipolysis, necrosis, and dehiscence. The skin in this region shows no distensibility as in other areas of the body because of fibrous connections with the fascial system, as described by Lockwood[24] and is called the superficial fascial system. This feature causes fluid collections such as seromas to exert pressure on the wound, spontaneously draining and contributing to wound dehiscence.

This is a preliminary study involving only 20 patients. A larger prospective study would provide a higher degree of evidence for our conclusions. Above all, as noted by Nicareta et al.,[25] when referring to gluteoplasty with fat grafting, the key to success is to have familiarity with the technique, knowledge of the gluteal topography, and understanding of the objective of the patients.

## CONCLUSIONS

The elaboration of technical modifications described here was based on anatomical and physiologic reasoning in an attempt to decrease our complication rates. Reduction of the undermined subcutaneous area, application of adhesion stitches, and maintenance of good vascularization in the sacral region are the keystones of our proposal. These modifications are simple and easy to perform. The rate of wound complications in the study sub-

**Fig. 7.** (*Above*, *left*) Appearance of the scar 8 days postoperatively. (*Center*, *left*) Appearance of the scar 2 months postoperatively. (*Above*, *right*) Appearance of the scar 3 months postoperatively. (*Center*, *right*) Appearance of the scar 6 months postoperatively. (*Below*) Appearance of the scar 1 year postoperatively.

**Fig. 8.** (*Above*) Photographs of a 22-year-old patient obtained preoperatively. The patient's main complaint was lack of projection. (*Below*) Photographs obtained 6 months postoperatively of oval-base, low-profile, 350-cc implant.

**Fig. 9.** (*Left*) Photograph of a 33-year-old patient obtained preoperatively. The patient's main complaint was lack of volume. (*Right*) Photograph obtained 6 months postoperatively of oval-base, low-profile, 400-cc implant.

jects, when compared with existing data related to the classic technique, either in the literature or in our service, suggests that the technical changes implemented are effective in the prevention of hematoma, seroma, infection, and wound dehiscence in gluteal augmentation surgery.

***Fernando Serra, M.D.***
Rua Visconde de Pirajá 550/1413
Ipanema, Rio de Janeiro, Brazil 22410-901
fserrag@gmail.com

## REFERENCES

1. Bartels RJ, O'Malley JE, Douglas WM, Wilson RG. An unusual use of the Cronin breast prothesis: Case report. *Plast Reconstr Surg.* 1969;44:500.
2. Cocke WM, Ricketson G. Gluteal augmentation. *Plast Reconstr Surg.* 1973;52:93.
3. González-Ulloa M. Gluteoplasty: A ten-year report. *Aesthetic Plast Surg.* 1991;15:85–91.
4. de La Peña JA, Rubio OV, Cano JP, Cedillo MC, Garcés MT. History of gluteal augmentation. *Clin Plast Surg.* 2006;33:307–319.
5. Mendieta CG. Gluteoplasty. *Aesthet Surg J.* 2003;23:441–455.
6. Harrison D, Selvaggi G. Gluteal augmentation surgery: Indications and surgical management. *J Plast Reconstr Aesthet Surg.* 2007;60:922–928.
7. Robles JM, Tagllapertra JC, Grandl YMA. Gluteoplastia de aumento: Implante submuscular. *Cir Plast Iberolatinoam.* 1984;10:365–375.
8. Vergara R, Marcos M. Intramuscular gluteal implants. *Aesthetic Plast Surg.* 1996;20:259–262.
9. Gonzales R. Augmentation gluteoplasty: The XYZ method. *Aesthetic Plast Surg.* 2004;28:417–425.
10. Mendieta C. Intramuscular gluteal augmentation technique. *Clin Plast Surg.* 2006;33:423–434.
11. Hidalgo JE. Submuscular gluteal augmentation: 17 years of experience with gel and elastomer silicone implants. *Clin Plast Surg.* 2006;33:435–447.
12. Serra F, Aboudib JH, Cedrola JP, de Castro CC. Gluteoplasty: Anatomic basis and technique. *Aesthet Surg J.* 2010;30:579–592.
13. Aiache AE. Gluteal re-contouring with combination treatments: Implants, liposuction, and fat transfer. *Clin Plast Surg.* 2006;33:395–403.
14. Benito-Ruiz J, Fontdevila J, Manzano M, Serra-Renom JM. Hip and buttock implants to enhance the feminine contour for patients with HIV. *Aesthetic Plast Surg.* 2006;30:98–103.
15. Di Martino M, Nahas FX, Barbosa MV, et al. Seroma in lipoabdominoplasty and abdominoplasty: A comparative study using ultrasound. *Plast Reconstr Surg.* 2010;126:1742–1751.
16. Bruner TW, Roberts TL III, Nguyen K. Complications of buttocks augmentation: Diagnosis, management, and prevention. *Clin Plast Surg.* 2006;33:449–466.
17. Alperovich M, Schreiber JE, Singh NK. Infection after augmentation gluteoplasty in a pregnant patient. *Aesthet Surg J.* 2007;27:622–625.
18. Cuenca-Guerra R, Quezada J. What makes buttocks beautiful? A review and classification of the determinants of gluteal beauty and the surgical techniques to achieve them. *Aesthetic Plast Surg.* 2004;28:340–347.
19. Baroudi R, Ferreira CA. Seroma: How to avoid it and how to treat it. *Aesthet Surg J.* 1998;18:439–441.
20. Rodrigues JN, Neto Guimarães GS, Benedik A, Neto Cammarota MC, Daher JC. Prótese glútea: O uso da lipoaspiração na melhora dos resultados. *Rev Bras Cir Plast.* 2010;25:344–348.
21. Badin AZ, Vieira JF. Endoscopically assisted buttocks augmentation. *Aesthetic Plast Surg.* 2007;31:651–656.
22. Pan WR, Taylor GI. The angiosomes of the thigh and buttock. *Plast Reconstr Surg.* 2009;123:236–249.
23. Tuinder S, Chen CM, Massey MF, Allen RJ Sr, Van der Huist R. Introducing the septocutaneous gluteal artery perforator flap: A simplified approach to microsurgical breast reconstruction. *Plast Reconstr Surg.* 2011;127:489–495.
24. Lockwood TE. Superficial fascia system (SFS) of the trunk and extremities: A new concept. *Plast Reconstr Surg.* 1991;87:1009–1018.
25. Nicareta B, Pereira LH, Sterodimas A, Illouz YG. Autologous gluteal lipograft. *Aesthetic Plast Surg.* 2011;35:216–224.

**APÊNDICE D -** Intramuscular Technique for gluteal augmentation: determination and quantification of muscle atrophy and implant position by computed tomographic scan - Terceiro artigo publicado



# Intramuscular Technique for Gluteal Augmentation: Determination and Quantification of Muscle Atrophy and Implant Position by Computed Tomographic Scan

Fernando Serra, M.D.
José Horácio Aboudib, M.D.
Ruy Garcia Marques, M.D., Ph.D.

*Rio de Janeiro, Brazil*

**Background:** New surgical techniques for gluteal augmentation have improved final results. It is estimated that more than 35,000 patients have undergone augmentation gluteoplasty using implants. The authors sought to determine and quantify the presence of muscle atrophy, and to evaluate implant positioning using the intramuscular technique.

**Methods:** Twenty-three female patients were selected prospectively for this study and underwent intramuscular gluteal augmentation using gluteal implants of a round or oval base. Computed tomographic scanning and three-dimensional volumetric reconstruction were used to investigate muscle atrophy and implant position, with comparison of the results between the preoperative scan and scans obtained 3, 6, and 12 months after surgery.

**Results:** Three-dimensional reconstruction and volumetric analysis showed muscular atrophy. After 12 months of follow-up, 34 gluteal muscles (17 patients) were analyzed, with 4.3 percent atrophy remaining on the right side and 2.6 percent on the left side. Twenty-three patients were studied regarding position (46 gluteal implants). All oval base implants introduced in a vertical direction (seven patients) turned to an oblique direction, following the direction of muscle fibers by 3 months after surgery. Two patients showed rotation of the implant.

**Conclusions:** The presence of a gluteal implant caused muscle atrophy. However, it did not lead to clinical or physical limitations. It is not important whether the implants are positioned vertically or obliquely, provided that they are symmetric. The technique proved to be safe in maintaining the intramuscular position of the implant, with good satisfaction for the patients. (*Plast. Reconstr. Surg.* 131: 253e, 2013.)

**CLINICAL QUESTION/LEVEL OF EVIDENCE:** Therapeutic, IV.

Historically, the gluteal region has been of great importance for the self-image and socialization of human beings in different ancient civilizations and in different cultures of the modern world.[1,2] Over the past 40 years, there has been a growing interest in gluteal augmentation by using implants. The development of new surgical techniques for implant position, such as subcutaneous, submuscular, subfascial, or intramuscular, has improved the results.[3–6] Currently, the intramuscular technique has greater acceptance among plastic surgeons.[7–9]

In the United States and in Brazil, data from the American Society of Plastic Surgeons and the Brazilian Society of Plastic Surgery have shown a significant increase in gluteal surgery during the past decade.[10,11] In plastic surgery,

*From the Plastic Surgery Service, Pedro Ernesto University Hospital, and the Department of General Surgery, Rio de Janeiro State University.*
*Received for publication August 6, 2012; accepted August 27, 2012.*

DOI: 10.1097/PRS.0b013e3182789d68

**Disclosure:** *The authors have no financial interest or commercial association regarding any of the subject matter or products mentioned in this article. The authors declare that no competing financial interests exist with regard to this article. There was no external funding for this study.*

since the description of this technique,[6] the use of intramuscular implants has been limited to the treatment of neuromuscular disorders and experimental surgery, whereas the use of intramuscular implants is new.[12,13] Sixteen years after the description of the intramuscular technique,[6] several studies have been published comparing results obtained with different techniques[14,15] but without evaluating the muscles involved in the operation. Publications related to postoperative complications did not refer to the behavior of the muscle itself.[16,17]

In the study of pressure sores, muscle tissue was more susceptible to external compression than the skin and was likely to undergo apoptosis and atrophy in both experimental models and in patients.[18–21] The behavior of the gluteus maximus muscle in the presence of cohesive gel implants in its interior and the biomolecular outcome of the fibers have not been studied. Also, whether the positioning of the implant within the muscle is stable has not been studied. The objective of the present study was to determine and quantify the presence of muscle atrophy by intrinsic compression and to evaluate the positioning of the implant introduced with the intramuscular technique.

**Table 1. Patient Selection**

| | |
|---|---|
| Inclusion criteria | |
| | Age between 20 and 50 yr |
| | Body mass index $<25$ kg/m$^2$ |
| | Lack of projection |
| | Lack of volume |
| Exclusion criteria | |
| | Previous gluteal surgery |
| | True ptosis |
| | Smokers |
| | Pregnancy |
| | Neoplasms |
| | Chronic diseases |

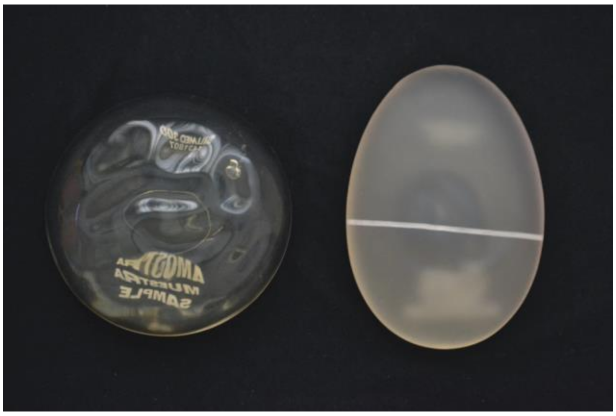


**Fig. 1.** (*Left*) Round base gluteal implant. (*Right*) Oval base gluteal implant.

## PATIENTS AND METHODS

### Study Design

This clinical prospective study was approved by the Research Ethics Committee of Pedro Ernesto University Hospital (no. 1888-CEP/HUPE) and was carried out from June of 2008 to October of 2010. All patients signed an informed consent form.

The sample consisted of 23 female patients who attended the gluteoplasty outpatient clinic of Pedro Ernesto University Hospital (Rio de Janeiro State University), provided that they met the inclusion criteria (Table 1). All patients were right-handed as determined by the information regarding which side would be used to kick a ball to hit an area on the wall.[22]

### Surgical Technique

All patients underwent spinal anesthesia, and all of the operative procedures were performed by the same surgeon (F.S.). The intramuscular technique[7,9] was used for all patients. The incision was 6 cm in length in the intergluteal fold, and the gluteal implant was positioned 2.0 to 2.5 cm deep inside the gluteus maximus muscle. The muscle closure was tension free, using 2-0 mononylon suture. Gel cohesive silicone implants of round or oval base were used (Silimed, Rio de Janeiro, Brazil) (Fig. 1).

### Postoperative Care

The patients were instructed to remain in the prone position just on the day of the operation. Supine position and sitting down were allowed on the day after, when the patients went home. Stitches were removed between postoperative days 10 and 14. Specific gluteal exercises were forbidden for 60 days, whereas upper limb exercises and sexual activity were allowed after 21 days.

The patients underwent computed tomographic scans for 1 year after the operation at postoperative months 3, 6, and 12. A computed tomographic scan was used to evaluate the positioning of the implant and to measure the volume of the gluteus maximus muscle through three-dimensional reconstruction (Figs. 2 through 5).

### Instruments

Computed tomographic scans were obtained using a GE CT scanner Hi Speed (General Electric, Milwaukee, Wis.) with spiral acquisition and

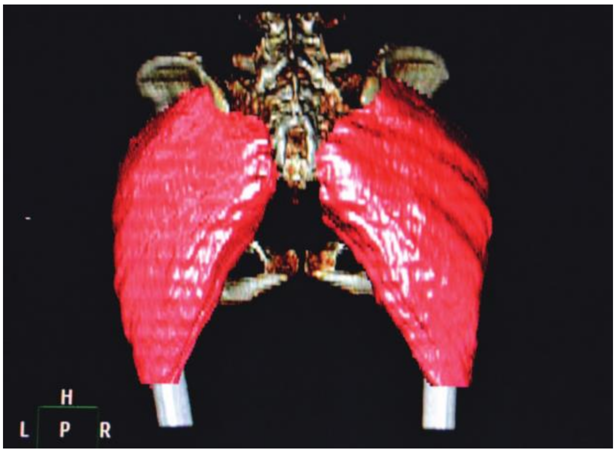



**Fig. 2.** Preoperative computed tomographic scan three-dimensional reconstruction (3-mm slice).

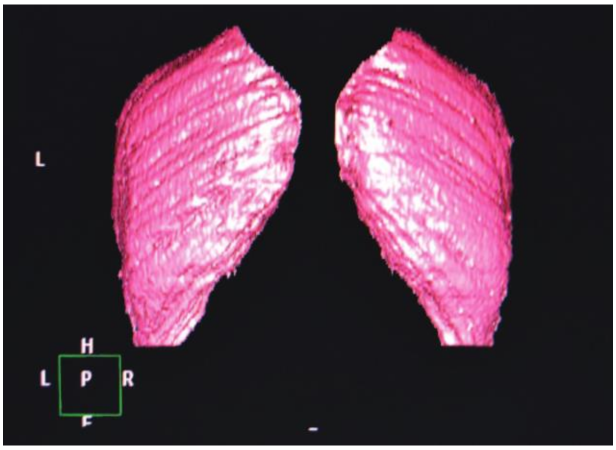



**Fig. 4.** Preoperative volumetric evaluation by computed tomographic scan.

a 3-mm slice thickness. The gluteal volumetric calculations were performed using the Extended Brilliance Workspace software (version 3.5.0 2250; Philips Medical Systems, Eindhoven, The Netherlands) in Hospital Quinta D'or (Rio de Janeiro, Brazil). Some images were acquired with the OsiriX application, version 3.9.4, 32-bit.

### Statistical Analysis

The data passed the normality test (Kolmogorov-Smirnov). The parametric paired *t* test was used to compare the gluteus maximus muscle volume before and after the operation. The level of significance was set at 0.05 for all tests.

## RESULTS

Twenty-three patients were submitted to the procedure, and although six did not conclude the follow-up, they could have had the implant positioning checked. Seventeen patients completed the study after 12 months of follow-up. The volume of the implant ranged from 270 to 400 cc (average, 313 cc). The mean operation time was 86.29 minutes (Table 2).

Muscular complications such as implant hernia or infection did not occur. All patients were satisfied with the outcome and resumed physical activities without restrictions 90 days after the operation.

The three-dimensional reconstruction and volumetric analysis during the first 3 months showed muscular atrophy. After the return of physical activity, muscle gained volume, with 4.3 percent atrophy remaining on the right side and 2.6 percent on the left side (mean values), as observed on computed tomographic scanning 12

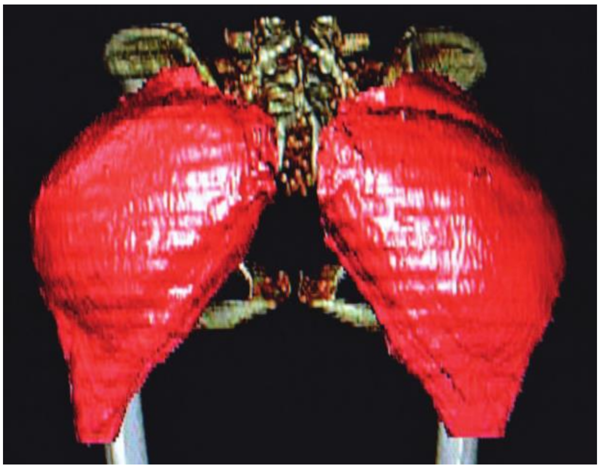


**Fig. 3.** Computed tomographic scan (3-mm slice) obtained 12 months postoperatively showing 400-cc, oval base, intramuscular gluteal implants.

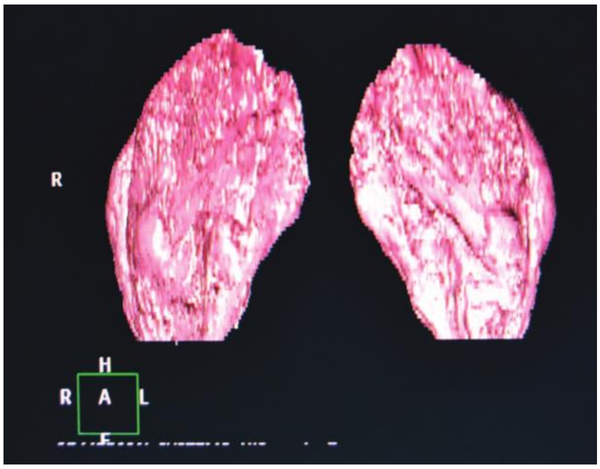



**Fig. 5.** Computed tomographic scan obtained 12 months postoperatively showing gluteus maximus deep surface. The implant is entirely intramuscular.

**Table 2. Sample Composition**

| Characteristic | Value |
|---|---|
| No. of patients | 23 |
| Age, yr | |
| Mean | 36.1 |
| Range | 22–42 |
| BMI, kg/m$^2$ | |
| Mean | 21.88 |
| Range | 19.2–27.7 |
| Operative time, min | |
| Mean | 86.2 |
| Range | 60–135 |
| Implant type | |
| Round | 9 |
| Oval | 14 |
| Implant volume, ml | |
| Mean | 313 |
| Range | 270–400 |

BMI, body mass index.

months after the operation (Fig. 6). The atrophy occurred mainly in the superficial part of the muscle (below the subcutaneous tissue). At the end of follow-up, there were no clinical changes in muscle function or in the performance of physical activity as reported by patients. There was also no statistically significant difference in the comparison of muscle volume preoperatively and 12 months postoperatively (paired *t* test).

Regarding position, 23 patients were studied (46 gluteal implants). All oval base implants introduced in a vertical position (seven patients) turned to an oblique direction following muscle fibers by 3 months after surgery (Fig. 7, *above*). Two patients showed rotation of the implant (Fig. 7, *center* and *below*). The mean follow-up was 13.6 months. There was no muscle disruption during this time (Fig. 8).

## DISCUSSION

Currently, gluteal augmentation surgery has become a frequent procedure in plastic surgery. With the available statistics of the American Society of Plastic Surgeons and the Brazilian Society of Plastic Surgery, it is estimated that more than 35,000 patients have been submitted to augmentation gluteoplasty with implants.[10,11]

The susceptibility of muscle tissue to injury by compression has been well defined.[20,21,23] Stekelenburg et al.[19] demonstrated the muscle changes secondary to compression with magnetic resonance imaging and histologic studies in rats. Siu et al.[18] related muscle apoptosis to early-stage compression in rats, as demonstrated by changes in muscle cell DNA.

Some atrophy secondary to muscle disuse is expected during the recovery period.[24] Trappe et al.[25] evaluated the reduction of muscle volume in astronauts after 6 months aboard the International Space Station, showing how the disuse can affect the striated skeletal muscles. The physiology of skeletal muscle and the maintenance of its function depend on a number of factors, such as dietary protein intake, physical activity, and age.[26]

The objective of this study was to evaluate the role of intrinsic muscle compression through the implant as a factor in muscle atrophy. The emergence of the intramuscular technique for gluteal augmentation showing better results and consequently the increase in the number of procedures performed aroused our curiosity about the possible future consequences secondary to compression of the intrinsic muscles. The use of a computed tomographic scan without contrast injection proved to be useful for assessing the evolution of muscle tissue in vivo. Other authors demonstrated the efficacy of three-dimensional reconstruction computed tomographic scans in the diagnosis of soft-tissue abnormalities and volumetric analysis.[27,28]

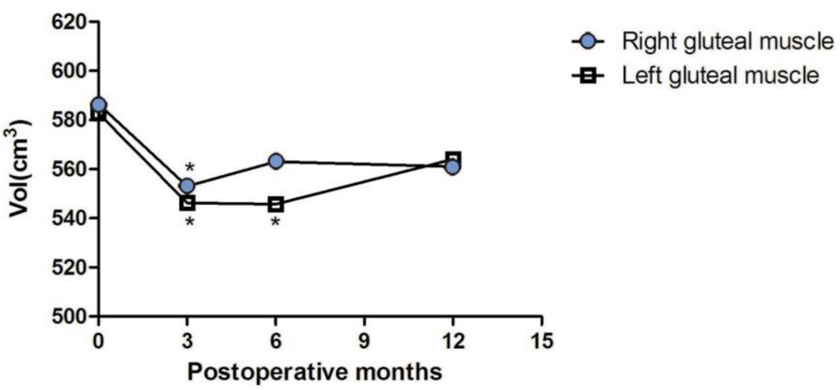



**Fig. 6.** Gluteal maximus muscle volume (right, $n = 17$; left, $n$ 17). *Statistically significant difference for paired $t$ test ($p < 0.05$) compared with the preoperative volume.

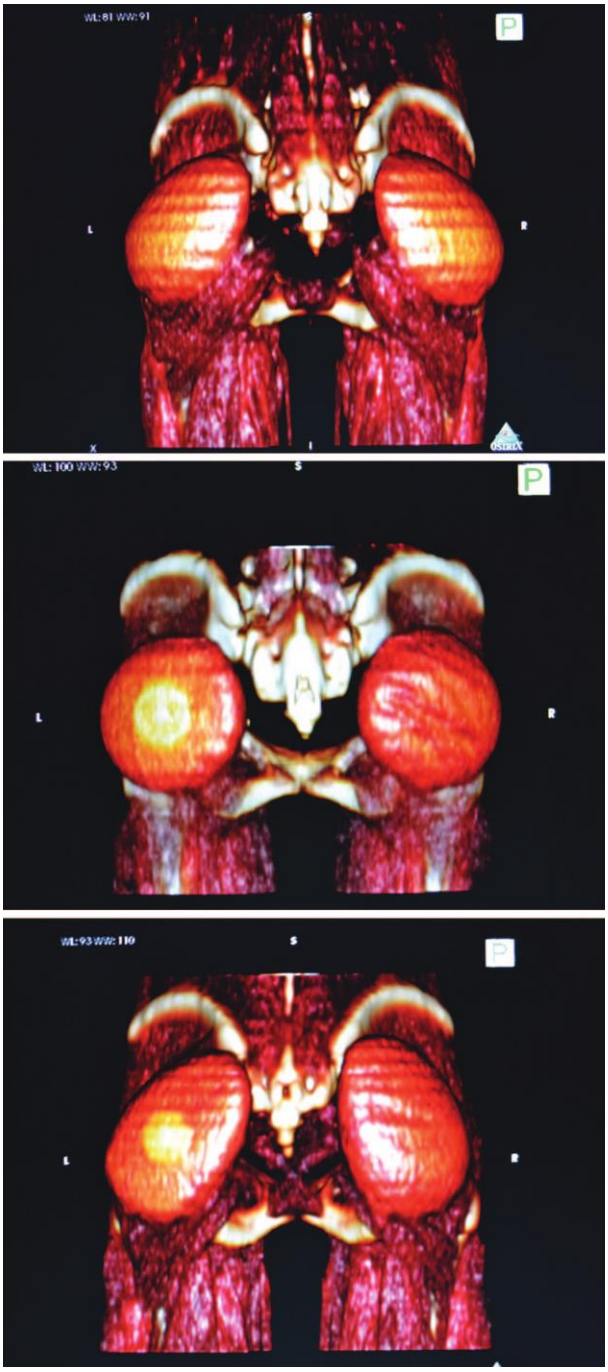



**Fig. 7.** (*Above*) Oval base, 300-cc implant, at 12 months postoperatively. It was inserted in vertical position. (*Center*) Round base, 300-cc implant, showing rotation at 14 months postoperatively. (*Below*) Oval base, 300-cc implant at 12 months postoperatively, showing implant rotation.

Muscle atrophy is multifactorial. We consider it physiologic when caused by muscle disuse during the postoperative period and when full recovery is achieved with the return of physical activities. During a follow-up of 12 months, the partial recovery of muscle volume was useful for identifying the cause of atrophy. After the resumption of normal physical activities, it is assumed that this atrophy still present after 12 months was predominantly attributable to intrinsic compression of the implant.

No similar plastic surgery studies were detected to compare the results. The right side recovered faster; at evaluation after 6 months there was no statistical difference regarding volume when compared with the preoperative scan. The left side gluteal muscle, despite having a longer recovery time, showed less atrophy observed on the 12-month scan. The presence of muscle atrophy of 4.3 percent on the right side and 2.6 percent on the left side 12 months after the operation was related to the compression caused by the implant. Despite this difference, the total muscular volume remained similar at the end of the study. The intramuscular dissection remained stable, and no muscle rupture occurred in any patient. There were no differences in the variation of the perioperative positioning of the oval base implant because, after 3 months, all implants followed a direction similar to that of the muscle fibers.

We attribute the rotation of the implant in two patients to the dissection of large intramuscular pockets, which led us to perform tension-free dissections of smaller pockets. We believe that the findings of this investigation are clinically important to establish the low risk of an intramuscular augmentation and to avoid complications such as rotation of the implant. This was a self-controlled study, and we believe that the presence of a control group and assessment of muscle function in the laboratory may give more strength to our conclusions.

## CONCLUSIONS

We conclude that the intramuscular technique for gluteal augmentation causes muscle atrophy without clinical or physical limitations. It is not important if the implants are positioned vertically or obliquely, provided that they are symmetric. The technique proved to be safe in maintaining the intramuscular position of the implant as observed on a computed tomographic scan 12 months after the operation, with good satisfaction for the patients. Thus, we are confident in continuing with one of the fastest growing techniques in plastic surgery.

*Fernando Serra, M.D.*
Rua Visconde de Pirajá 550/1413
Ipanema, Rio de Janeiro, Brazil 22410-901
fserrag@gmail.com

**Fig. 8.** (*Above*) Preoperative photographs of a 34-year-old patient whose main complaint was lack of volume and projection. (*Below*) Photographs obtained 8 months postoperatively of the patient with oval base, low-profile, 350-cc implants.

## REFERENCES


1. Singh D. Universal allure of the hourglass figure: An evolutionary theory of female physical attractiveness. *Clin Plast Surg.* 2006;33:359–370.
2. De La Peña JA, Rubio OV, Cano JP, Cedillo MC, Garcés MT. History of gluteal augmentation. *Clin Plast Surg.* 2006;33:307–319.
3. González-Ulloa M. Gluteoplasty: A ten-year report. *Aesthetic Plast Surg.* 1991;15:85–91.
4. Robles JM, Tagllapertra JC, Grandl YMA. Augmentation gluteoplasty: Submuscular implant. *Cir Plast Iberolatinoam.* 1984;10:365–375.
5. De La Peña JA, Monjardin LH, Gamboa LF. Augmentation gluteoplasty: Anatomical and clinical considerations. *Plast Cosmet Surg.* 2000;17:1–12.
6. Vergara R, Marcos M. Intramuscular gluteal implants. *Aesthetic Plast Surg.* 1996;20:259–262.
7. Serra F, Aboudib JH, Cedrola JP, De Castro CC. Gluteoplasty: Anatomic basis and technique. *Aesthet Surg J.* 2010;30:579–592.

8. Gonzales R. Augmentation gluteoplasty: The XYZ method. *Aesthetic Plast Surg.* 2004;28:417–425.
9. Aboudib JH, Serra F, De Castro CC. Gluteal augmentation: Technique, indications, and implant selection. *Plast Reconstr Surg.* 2012;130:933–935.
10. American Society of Plastic Surgeons. ASPS National Clearinghouse of Plastic Surgery Procedural Statistics. Available at: http://www.plasticsurgery.org/News-and-Resources/2011-Statistics-.html. Accessed July 2, 2012.
11. Instituto Brasileiro de Opinião Pública e Estatística (IBOPE). Mercado de cirurgia plástica está se desenvolvendo no Brasil. Available at: http://www.ibope.com.br/calandraWeb/servlet/CalandraRedirect?temp=6&proj=PortalIBOPE&pub=T&nome=home_materia&db=caldb&docid=7348DFAD7C9BBFF88325797C006CD429. Accessed July 2, 2012.
12. Chae J, Hart R. Intramuscular hand neuroprosthesis for chronic stroke survivors. *Neurorehabil Neural Repair* 2003;17:109–117.
13. Xaymardan M, Gibbins JR, Zoellner H. Adipogenic healing in adult mice by implantation of hollow devices in muscle. *Anat Rec.* 2002;267:28–36.
14. Harrison D, Selvaggi G. Gluteal augmentation surgery: Indications and surgical management. *J Plast Reconstr Aesthet Surg.* 2007;60:922–928.
15. Mendieta CG. Gluteoplasty. *Aesthetic Surg J.* 2003;23:441–455.
16. Bruner TW, Roberts TL III, Nguyen K. Complications of buttocks augmentation: Diagnosis, management, and prevention. *Clin Plast Surg.* 2006;33:449–466.
17. Alperovich M, Schreiber JE, Singh NK. Infection after augmentation gluteoplasty in a pregnant patient. *Aesthet Surg J.* 2007;27:622–625.
18. Siu PM, Tam EW, Teng BT, et al. Muscle apoptosis is induced in pressure-induced deep tissue injury. *J Appl Physiol.* 2009;107:1266–1275.
19. Stekelenburg A, Oomens CW, Strijkers GJ, Nicolay K, Bader DL. Compression-induced deep tissue injury examined with magnetic resonance imaging and histology. *J Appl Physiol.* 2006;100:1946–1954.
20. Linder-Ganz E, Engelberg S, Scheinowitz M, Gefen A. Pressure-time cell death threshold for albino rat skeletal muscles as related to pressure sore biomechanics. *J Biomech.* 2006;39:2725–2732.
21. Linder-Ganz E, Gefen A. Mechanical compression-induced pressure sores in rat hindlimb: Muscle stiffness, histology, and computational models. *J Appl Physiol.* 2004;96:2034–2049.
22. Van Cingel HER, Kleinrensink GJ, Rooijens PP, et al. Learning effect in isokinetic testing of ankle invertors and evertors. *Isok Exerc Sci.* 2001;9:171–177.
23. Breuls RG, Bouten CV, Oomens CW, Bader DL, Baaijens FP. Compression induced cell damage in engineered muscle tissue: An in vitro model to study pressure ulcer aetiology. *Ann Biomed Eng.* 2003;31:1357–1364.
24. Sato S, Shirato K, Tachiyashiki K, Imaizumi K. Muscle plasticity and $\beta$2-adrenergic receptors: Adaptive responses of $\beta$2-adrenergic receptors expression to muscle hypertrophy and atrophy. *J Biomed Biotechnol.* 2011;2011:10 pp.
25. Trappe S, Costill D, Gallagher P, et al. Exercise in space: Human skeletal muscle after 6 months aboard the International Space Station. *J Appl Physiol.* 2009;106:1159–1168.
26. Campbell WW, Leidy HJ. Dietary protein and resistance training effects on muscle and body composition in older persons. *J Am Coll Nutr.* 2007;26:696S–703S.
27. Park SU, Shim JS. Measurement of breast volume after breast reconstruction using computed tomographic scanning. *Plast Reconstr Surg.* 2012;129:1020e–1021e.
28. Papageorgiou KI, Mancini R, Garneau HC, et al. A three-dimensional construct of the aging eyebrow: The illusion of volume loss. *Aesthet Surg J.* 2012;32:46–57.

**APÊNDICE E -** Gluteal augmentation: technique, indications, and implant selection - Quarto artigo publicado

IDEAS AND INNOVATIONS

# Gluteal Augmentation: Technique, Indications, and Implant Selection

Jose Horacio Aboudib, M.D.
Fernando Serra, M.D.
Claudio Cardoso de Castro, M.D.

*Rio de Janeiro, Brazil*

**Summary:** Silicone implants have been used for gluteal augmentation for the past 40 years. Several techniques have been described for cosmetic purposes, but many plastic surgeons do not feel that performing the operation is safe. In this article, a technique is described to reduce the complication rate, improve the final results, and develop an easy way of understanding and learning this procedure. Based on surgical simulation involving 10 fresh cadavers, the authors have determined the goals for making the operation simpler and safer. One hundred three patients have undergone the operation performed by the staff or by the plastic surgery resident under supervision. There was seroma in 3.88 percent, dehiscence of the sutures in 5.8 percent, infection and removal of the implant in one case (0.97 percent), and no hematoma. The patient satisfaction rate was high. Anatomical dissections allowed the authors to gain experience and confidence regarding the plane of undermining, avoiding damage to the sciatic nerve, and the placement of the prosthesis, keeping it in place. The technique is easy to understand and learn. (*Plast. Reconstr. Surg.* 130: 933, 2012.)

**CLINICAL QUESTION/LEVEL OF EVIDENCE:** Therapeutic, IV.

Body contour is a concern for most women, and buttocks reshaping has been increasing in importance. Silicone implants were used in the buttocks for the first time in 1969.[1] González-Ulloa in the 1970s was the first to develop the technique to introduce silicone implants in the gluteal region to increase its volume for cosmetic purposes.[2] Since then, several authors, including Vergara and Marcos[3] (intramuscular placement), de la Peña et al.[4] (subfascial placement), and Robles et al.[5] (submuscular placement), have published different procedures for buttocks augmentation, but complications or bad results[6] such as seroma and implant hernia have led us to study anatomy[7] and develop the technique proposed in this article.

## PATIENTS AND METHODS

### Technique

Based on surgical simulation involving 10 fresh cadavers, we concluded that intramuscular implantation using a 2-cm-deep muscular pocket was sufficient and reliable to attain all that is necessary to keep the prosthesis in place and to avoid injuring the sciatic nerve and any other structure (Figs. 1 and 2).

The incision is a 6-cm-long cutaneous fuse in the intergluteal fold with its decortications (Fig. 3). The subcutaneous tissue dissection directing to the muscle preserves the sacrum-cutaneous ligament inside the tissue island in the midline (Fig. 4). The tissue island isolates both sides and is helpful in the intergluteal fold reconstruction. The subcutaneous dissection above the gluteus maximus fascia is as small as necessary to open it.

A blunt dissector is necessary to make the intramuscular pocket for implant placement; it should exceed the implant base size by 2 to 3 cm. In the technique described, the implant is located within the muscle, 2 cm deep inside.

### Implants

Since the beginning of the use of gluteoplasty, implants with an oval or round base have been used.[2] This concept is still used; otherwise, the gel has gotten heavier and more cohesive with a smooth surface. The dimensions of the implants have changed to ones with higher profiles. The

*From the Plastic Surgery Service, University of the State of Rio de Janeiro.*
*Received for publication January 29, 2012; accepted March 6, 2012.*

DOI: 10.1097/PRS.0b013e31825dc3da

**Disclosure:** *The authors have no financial interest to declare in relation to the content of this article.*

point of higher projection of the implant should be placed in the thickest point of the buttocks, usually at the level of the pubic symphysis.

**Fig. 1.** Incision and subcutaneous tissue undermining.

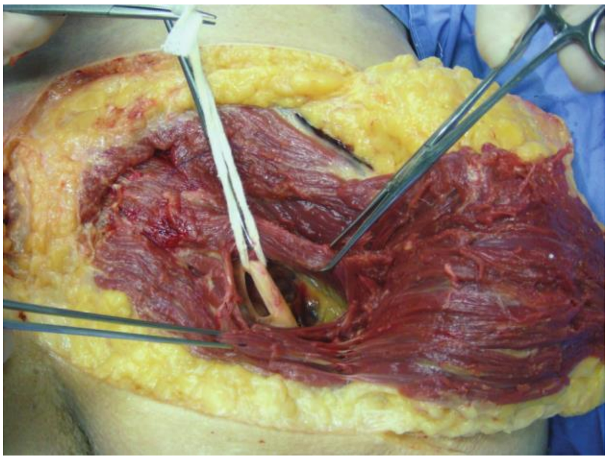


**Fig. 2.** Sciatic nerve dissection. A thick layer of muscle protects it.

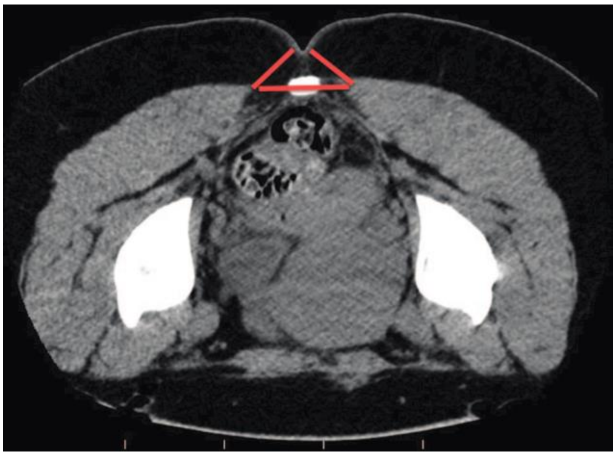


**Fig. 4.** Computed tomographic scan showing the sacrum-cutaneous ligament that is preserved in the midline.

### Postoperative Period

The patient should stay in the prone position just on the day of the operation. Supine position and sitting are allowed on the day after, when the patient goes home. The stitches are removed between postoperative days 10 and 14. Specific gluteal exercises are forbidden for 60 days; otherwise, upper limb exercises and sexual activity are allowed after 21 days.

## RESULTS

One hundred three operations, under spinal anesthesia, were performed from January of 2009 to July of 2011. The ages of the patients ranged from 19 to 59 years. All of the patients were discharged on the next day. Drains were not used. We had seroma in 3.88 percent, dehiscence of the sutures in 5.8 percent, infection and removal of the implant in one case (0.97 percent), and no hematoma. In cases of seroma, we open the wound for drainage and keep it opened until there is no

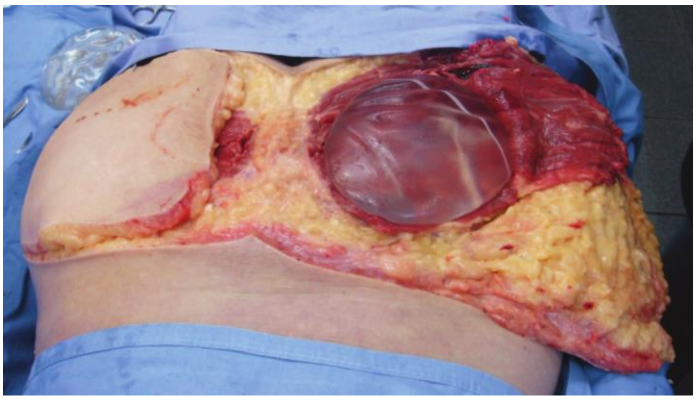


**Fig. 3.** Oval base prosthesis position.

more drainage, and then we suture the wound. The patient satisfaction rate was high. Surgery was performed by the medical staff or by the resident under supervision.

## DISCUSSION

We believe that the intramuscular approach has brought new possibilities for gluteal augmentation since its publication in 1996.[3] This technique allows the surgeon to place the implant in the best position for each type of buttock, independent of the sciatic nerve position, because the muscle will always protect it. In our hands, it represents a great increase in the final results compared with those that we used to achieve performing the submuscular technique.[5] The anatomical basis method[7] is an easy way to learn and perform the operation.

Bruner et al.[6] have described high rates of wound complications discussing the statistic of major authors on this subject. We believe that experience has improved these results in the past 5 years, and in our group the complication rates did decrease during this period, considering that in 2006 we had numbers for seroma and dehiscence similar to those described in the article by Bruner et al.

Regarding the implant indication, we consider that the oval implants are more versatile and fit better for the majority of patients. The round ones are indicated for short-stature patients, with the buttocks measures similar in length and width.

Gluteal augmentation has become more frequent over the past 5 years, but there is no consensus regarding the surgical technique. Other authors have shown good results with the subfascial technique,[4,8] which is a technique with which we have no experience. The discussion should continue, and new approaches for uncommon situations should be published, such as that by Jaimovich et al.,[9] who proposed the internal suture technique. Although an autologous tissue, fat injection is not as predictable as implants, and studies reporting long-term results are needed to evaluate its behavior over the years.

## CONCLUSIONS

Anatomical dissections permitted us to gain experience and confidence regarding the plane of undermining, avoiding damage to the sciatic nerve and enabling the placement of the prosthesis so as to keep it in place. The proper location of the implant has been proved by computed tomographic scans, in addition to its immobility, symmetry, lack of herniation, and lack of capsular contracture. The depth of the position is approximately 2 cm that, with absorption, becomes 0.5 to 0.7 cm.

***Claudio Cardoso de Castro, M.D.***
Rua Domingos Ferreira, 140/301
22050010 Copacabana, Rio de Janeiro, Brazil
cdecastro@uol.com.br

## REFERENCES

1. Bartels RJ, O'Malley JE, Douglas WM, Wilson RG. Unusual use of the Cronin breast prothesis: Case report. *Plast Reconstr Surg.* 1969;44:500.
2. González-Ulloa M. Gluteoplasty: A ten-year report. *Aesthetic Plast Surg.* 1991;15:85–91.
3. Vergara R, Marcos M. Intramuscular gluteal implants. *Aesthetic Plast Surg.* 1996;20:259–262.
4. de la Peña JA, Rubio OV, Cano JP, Cedillo MC, Garcés MT. Subfascial gluteal augmentation. *Clin Plast Surg.* 2006;33:405–422.
5. Robles JM, Tagllapertra JC, Grandl YMA. Gluteoplastia de aumento: Implante submuscular. *Cir Plást Iberolatinoam.* 1984;10:365–375.
6. Bruner TW, Roberts TL III, Nguyen K. Complications of buttocks augmentation: Diagnosis, management, and prevention. *Clin Plast Surg.* 2006;33:449–466.
7. Serra F, Aboudib JH, Cedrola JP, de Castro CC. Gluteoplasty: Anatomic basis and technique. *Aesthet Surg J.* 2010;30:579–592.
8. Senderoff DM. Buttock augmentation with solid silicone implants. *Aesthet Surg J.* 2011;31:320–327.
9. Jaimovich CA, Almeida MW, Aguiar LF, da Silva ML, Pitanguy I. Internal suture technique for improving projection and stability in secondary gluteoplasty. *Aesthet Surg J.* 2010;30:411–413.

**APÊNDICE F -** Gluteal implant displacement: diagnosis and treatment -Quinto artigo aceito para publicação

**Accept in Feb, 10th 2014.**
**PLASTIC AND RECONSTRUCTIVE SURGERY**
**ISSN:** 0032-1052
**Online ISSN:** 1529-4242
**Frequency:** 12 issues per year
**Ranking:** 13 of 198 in Surgery
**Impact Factor:** 3.535

**GLUTEAL IMPLANT DISPLACEMENT: DIAGNOSIS AND TREATMENT**

**FERNANDO SERRA, M.D.**

Plastic Surgery Staff, Plastic Surgery Service, Pedro Ernesto University Hospital, Rio de Janeiro State University, Brazil

**JOSE HORACIO ABOUDIB, M.D.**

Assistant Professor, Chief of the Plastic Surgery Service, Pedro Ernesto University Hospital, Rio de Janeiro State University, Brazil2

**DISCLOSURES:**

There was no external funding for this study. The authors have no financial interest or commercial association with any of the subject matter or products mentioned in this article. The authors declare that no competing financial interests exist with regard to the present article.

**ABSTRACT Background-** First started in 1969, the Buttocks implant surgery has presented great evolution since the introduction of the intramuscular technique. This technique provides good implant coverage and protects the sciatic nerve from compression. However, it enables the occurrence of a new complication, intramuscular hernia or implant displacement. The goal of this research study is to describe, classify and standardize the treatment of gluteal implant displacement. **Methods-** The treatment algorithm was developed after the dissection of fresh human cadavers and the analysis of CT scans in patients with implant displacement. After elaborating the treatment protocol for implant displacement, it was prospectively applied in 24 patients that presented visible implants. **Results-** Intramuscular dissection has proven to be technically possible when a minimum of 2cm muscle thickness is achieved. One-stage surgery treatment was applied in 41 buttocks (21 patients). The control CT scan taken three months after surgery has shown fibrosis in the buttocks area, corresponding to the subcutaneous capsule housing the implant in the anomalous position. The operatory wound complications were more frequent and treatment failure with relapse of the implant superficial displacement occurred in only one patient unilaterally (1/47=2.1%). **Conclusions-** The treatment of gluteal implant displacement can be a one-stage surgical procedure for most patients. This decision is based on the thickness of the gluteus maximus muscle just below the implant. **LEVEL OF EVIDENCE: IV KEY WORDS-** Gluteal implants; prosthesis; complications.

## INTRODUCTION

First started in 1969[1], the Buttocks implant surgery has presented great evolution since the introduction of the intramuscular technique[2]. This technique has provided the achievement of more natural results, better pain control and lower complication rates as ptosis, capsular contracture and noticeable implants[3,4]. Currently, the increase in the number of gluteoplasty surgeries has also provided an increase in the total number of complications. The most common postoperative complications are seroma and dehiscence[5-7], but both have been studied and the literature provides us ways to prevent and treat such complications[8].

The intramuscular technique provides good implant coverage and protects the sciatic nerve from compression[9,10]. However, it enables the occurrence of a new complication, intramuscular hernia or implant displacement. In most cases, this event is the result of a very superficial intramuscular dissection or accidental rupture of the gluteus maximus muscle during dissection. The implant superficialization can also occur secondarily to local trauma or if excessive physical activity is performed during the first 60 days after surgery.

The lack of publication on the subject and the deficiency of protocols for the treatment of this complication create uncertainty in surgeons and patients who face this problem. The goal of this research study is to describe, classify and standardize the treatment of gluteal implant displacement.

## METHOD

This study was conducted according to the ethical standards laid down in Declaration of Helsinki. Written informed consent was obtained from all patients prior to their inclusion in the study. It was performed with the dissection of fresh human cadavers and with the analysis of CT scans in patients with implant displacement. After elaborating the treatment protocol for implant displacement, itwas prospectively applied in 24 patients from the private practice of the first author (F.S.) and the Pedro Ernesto University Hospital and between February 2010 and June 2013.

The cadaver dissection aimed at establishing the least muscular thickness required for a safe intramuscular dissection and the insertion of implants. The analysis of the CT scans allowed us to classify the type of implant displacement and evaluate the muscle thickness in order to define the treatment to be applied. High cohesive gel, oval base, 350cc, Silimed® implants were used.

### Surgical Technique

A fusiform incision in the midline, 6cm long by 0.5cm wide withot incision directly in the intergluteal sulcus. The subcutaneous layer is dissected at 45° beveling outward on both sides, preserving the fat and fibrous tissue of the intergluteal sulcus as performed for primary gluteal augmentation[3,4,8,11] (Fig 1). Subcutaneous dissection and opening of the superficial capsule with the removal of the displaced implants. Radial incisions on the capsule and suturing of the superficial and deep planes, with or without lifting, according to the overlying sagging skin. Intramuscular blunt dissection, deep to the fibrous capsule, according to the anatomical references of the gluteus maximus muscle as the iliac crest and the iliotibial tract[3]. The intramuscular dissection should be carefully performed in an attempt to avoid disruption of the roof of this new pocket and communication with the superficial one. An anchoring suture is positioned on the lateral edge of the muscle incision to prevent muscle rupture during the insertion of the new implant (Figs. 2 and 3).

The Silimed Quartzo (oval base) implants are positioned at an oblique angle, following the same direction as the gluteal maximus muscle fibers. After the implant is inside the muscle, the anchoring suture is removed, and a nylon 2.0 suture is used to the muscle closure. Drains are placed inside the superficial pocket bilaterally. The subcutaneous layer and the skin are sutured.

## RESULTS

Intramuscular dissection has proven to be technically possible when a minimum of 2cm muscle thickness is achieved. Dissection in thinner muscle segments has presented muscle rupture during the detachment maneuver or the insertion of the implants (Fig. 4).

The evaluation through CT scans of 24 patients (48 buttocks) has allowed us to observe the implants in different planes, as well as the damages caused to the gluteus maximus muscle in different levels (Table 1).

The algorithm (Fig. 5) was applied prospectively in 24 patients, totaling 47 buttocks. Only one patient has presented implant displacement unilaterally. Three patients have shown indication for implant removal in the first surgical time and reoperation after 4-6 months for the insertion of new implants. These patients have chosen to keep the implants in anomalous position. One-stage surgery treatment was applied in 41 buttocks (21 patients). The implant volume ranged from 300 - 400cc (average=350cc). The control CT scan taken three months after surgery has shown fibrosis in the buttocks area, corresponding to the subcutaneous capsule housing the implant in the anomalous position (Fig 6). This fibrous tissue has caused buttocks irregularities of varying intensity.

The overall complication rate was 46.8% (Table 2). The operatory wound complications were more frequent and treatment failure with relapse of the implant superficial displacement occurred in only one patient unilaterally (1/47=2.1%) (Fig. 7). During the preoperative care, two patients presented large superficial seroma on the implant site before surgical correction (Fig. 8). In one of these cases, mycobacterium infection was diagnosed after the implant plane was changed.

## DISCUSSION

The intramuscular technique described by Rafael Vergara[2] in 1996 has provided more natural, safe and long-lasting results when compared to other gluteoplasty augmentation techniques[7,12]. During the last decade, the technique was widespread and popularized among plastic surgeons and this has been the primary factor for the increase in demand for this surgery[11]. The increase in the number of surgeries also brought with it an increase in the number of complications. Implant displacement and, mainly, its superficialization, represents a more complex situation, in which the surgeon has to decide between a one-stage or two-stage surgery procedure, with four to six months interval between them.

Intramuscular dissection based on standard anatomical references, especially the point of origin and insertion of the gluteus maximus simplifies its execution, preventing implant malpositioning[3,4]. During the learning curve, the fear of causing injury to the sciatic nerve leads surgeons to perform a very superficial intramuscular dissection or rupture of the muscle fibers during dissection. Muscle injuries are not always diagnosed during surgery. Muscle tone will make the implant to leave the muscle to a region of lower pressure, the subcutaneous tissue. Once in a superficial pocket, the subcutaneous tissue, these implants can suffer more complications as ptosis and capsular contracture[6]. The inadvertent position of the implant into a submuscular plane and injuries to the sciatic nerve are rarely seen due to the large thickness of the gluteus maximus. The intramuscular dissection can be guided by intra-operative ultrasound that can be helpful for the inexperienced surgeon who has just started on gluteoplasty surgeries[13].

We have treated gluteal implant displacement based on two main factors, which are the remaining muscle for new intramuscular dissection and the capsule that covers the displaced implant (Fig 9). Based on cadaver dissection, the minimum thickness required for muscle dissection and insertion of implants was 2cm. Muscles thinner than 2cm tend to rupture during dissection or insertion of implants. When the remaining muscles present less than 2cm thickness, implant removal is indicated. After 4 - 6 months, another operation is carried out to insert new implants using the intramuscular technique. 350cc implants were used in the cadaver dissection because it was the average volume used by the main author. The superficial fibrous capsule presented variable performance after the removal of the subcutaneous implants. Local scar forces lead to capsular retractions that can result in unpredictable gluteal irregularities. Our patients are informed about this chance before undergoing surgery. Fat graft in a second operative time may be helpful when treating these complications.

Wound complications as seroma and dehiscence are the most frequent ones in primary gluteoplasty[5-8]. Some authors have associated seroma to subcutaneous detachment[8,14]. In the gluteal area, seromas often drain through the surgical wound and are the cause of small dehiscences. During reoperation, subcutaneous detachment is enlarged and, then, the increase of seroma and small dehiscences is expected. Aspirative draining or insertions of quilting sutures were helpful in preventing these complications after the primary surgery, however, in the secondary surgery, the incidence of seroma and dehiscence remained high. The incidence of major chronic seromas may be related to mycobacterioses infection[15]. In these cases, our current routine is just the removal of the implants and reoperation, after 4-6 months, in case of negative culture results.

Chronic postoperative complications have a great psychological impact on patients. Patients with gluteal implant displacement do not easily find a solution to their problems. All of them have presented psychological disruption which has resulted in a negative response to treatment when the initial indication was implant removal. On the other hand, those patients treated in a one-stage surgical time presented high level of satisfaction (Figs. 10-15).

According to the main authors, the overall complication rate exceeded the one of primary gluteoplasty[5-7]. The use of this proposed guideline led 87.23% of the cases to primary treatment (41/47), presenting treatment failure in 2.1% of the cases, index rate significantly lower than the total of complications that, in its majority, did not compromised the final result.

## CONCLUSION

The treatment of gluteal implant displacement can be a one-stage surgical procedure for most patients. This decision is based on the thickness of the gluteus maximus muscle just below the implant. Using this protocol and performing a one- stage surgery treatment in patients with the gluteus maximus muscle thicker than 2cm have allowed us to apply the proper treatment efficiently.

**References:**


1. **Bartels RJ, O'Malley JE, Douglas WM, Wilson RG. Unusual use of the Cronin breast prothesis. *Plastic and reconstructive surgery.* 1969;44:500.**

2. **Vergara R, Marcos M. Intramuscular gluteal implants Aesthetic Plast Surg. . *Plastic and reconstructive surgery.* 1996;20:259-262.**

3. **Aboudib JH, Serra F, de Castro CC. Gluteal augmentation: technique, indications, and implant selection. *Plastic and reconstructive surgery.* Oct 2012;130(4):933-935.**

4. **Gonzalez R. Augmentation Gluteoplasty: The XYZ Method. *Aesthetic Plastic Surgery.* 2004;28:417-425.**

5. **Bruner TW, Roberts TL, 3rd, Nguyen K. Complications of buttocks augmentation: diagnosis, management, and prevention. *Clinics in plastic surgery.* Jul 2006;33(3):449-466.**

6. **Flores-Lima G, Eppley BL, Dimas JR, Navarro DE. Surgical pocket location for gluteal implants: a systematic review. *Aesthetic Plast Surg.* Apr 2013;37(2):240-245.**

7. **Mofid MM, Gonzalez R, de la Pena JA, Mendieta CG, Senderoff DM, Jorjani S. Buttock augmentation with silicone implants: a multicenter survey review of**

2226 patients. *Plastic and reconstructive surgery.* Apr 2013;131(4):897- 901.

8. Serra F, Aboudib JH, Marques RG. Reducing wound complications in gluteal augmentation surgery. *Plastic and reconstructive surgery.* Nov 2012;130(5):706e-713e.

9. Mendieta CG. Intramuscular gluteal augmentation technique. *Clinics in plastic surgery.* Jul 2006;33(3):423-434.

10. Serra F, Aboudib JH, Marques RG. Intramuscular technique for gluteal augmentation: determination and quantification of muscle atrophy and implant position by computed tomographic scan. *Plastic and reconstructive surgery.* Feb 2013;131(2):253e-259e.

11. Serra F, Aboudib JH, Cedrola JP, de Castro CC. Gluteoplasty: anatomic basis and technique. *Aesthetic surgery journal / the American Society for Aesthetic Plastic surgery.* Jul-Aug 2010;30(4):579-592.

12. Gonzalez R. Etiology, definition, and classification of gluteal ptosis. *Aesthetic Plast Surg.* May-Jun 2006;30(3):320-326.

13. Gonzalez R, Mauad F. Intraoperative ultrasonography to guide intramuscular buttock implants. *Aesthetic surgery journal / the American Society for Aesthetic Plastic surgery.* Jan 2012;32(1):125-126.

14. Baroudi R FC. Seroma: How to avoid it and how to treat it. *Aesthetic surgery journal / the American Society for Aesthetic Plastic surgery.* 1998;18(6):439-441.

15. Thomas M, D'Silva JA, Borole AJ, Chilgar RM. Periprosthetic atypical mycobacterial infection in breast implants: a new kid on the block! *Journal of plastic, reconstructive & aesthetic surgery : JPRAS.* Jan 2013;66(1):e16-19.

**FIGURES:**

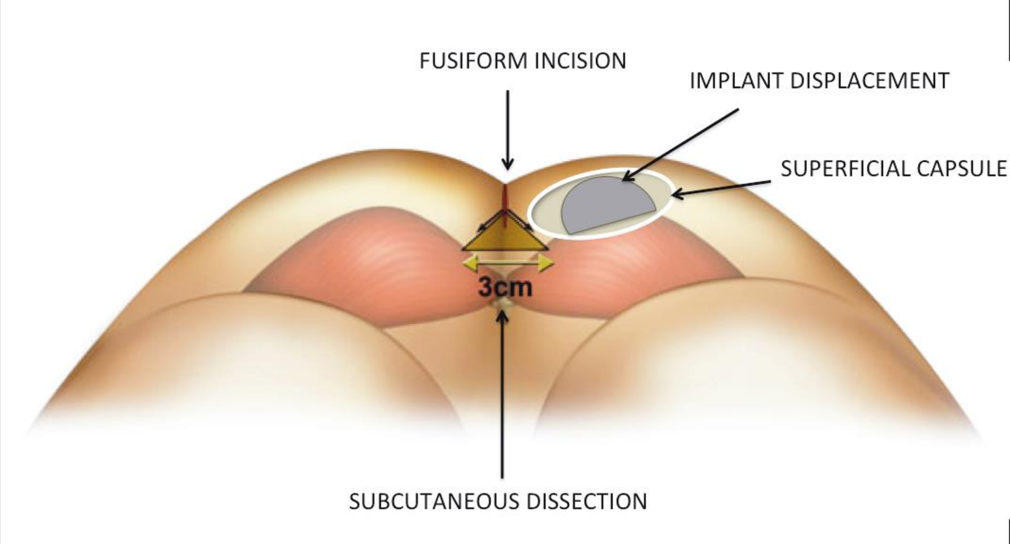



Figure 1- The most frequent situation: implant superficial to the muscle; In the center: how to preserve the intergluteal sulcus.

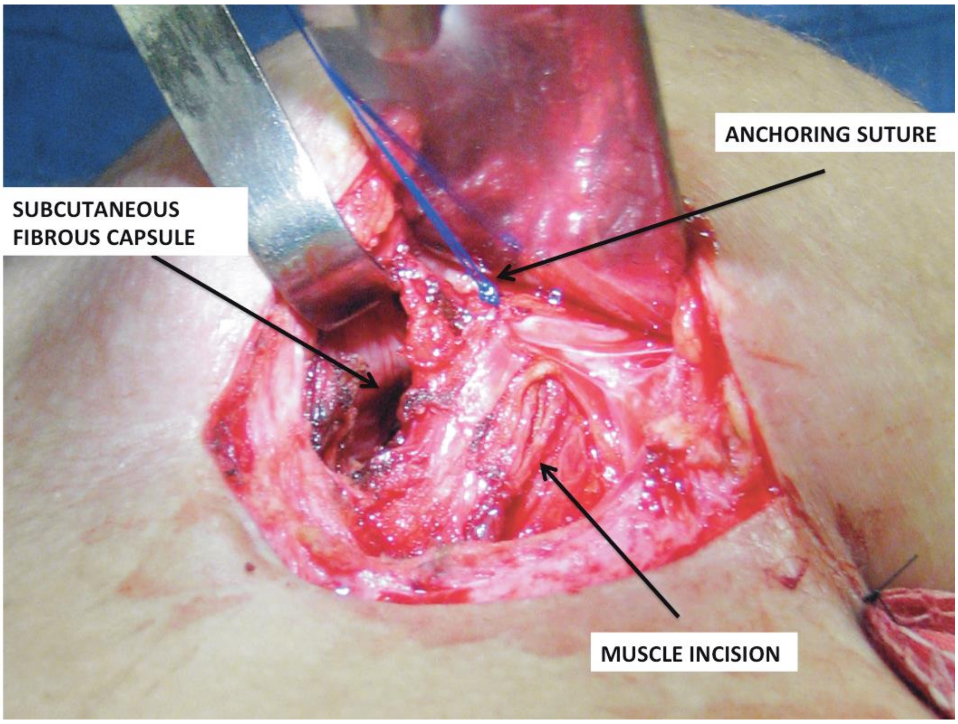



Figure 2- Anchoring suture to avoid muscle disruption during the introduction of the implant. Left- fibrous capsule; Right- deeper intramuscular dissection.

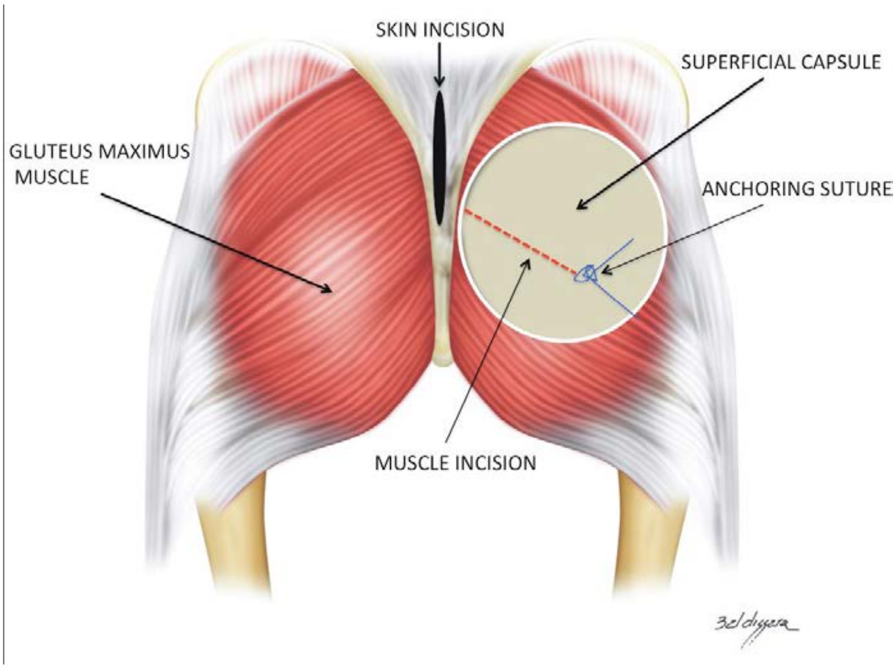



Figure 3- The position of the muscle incision and anchoring suture to prevent muscle rupture while introducing the new implant.

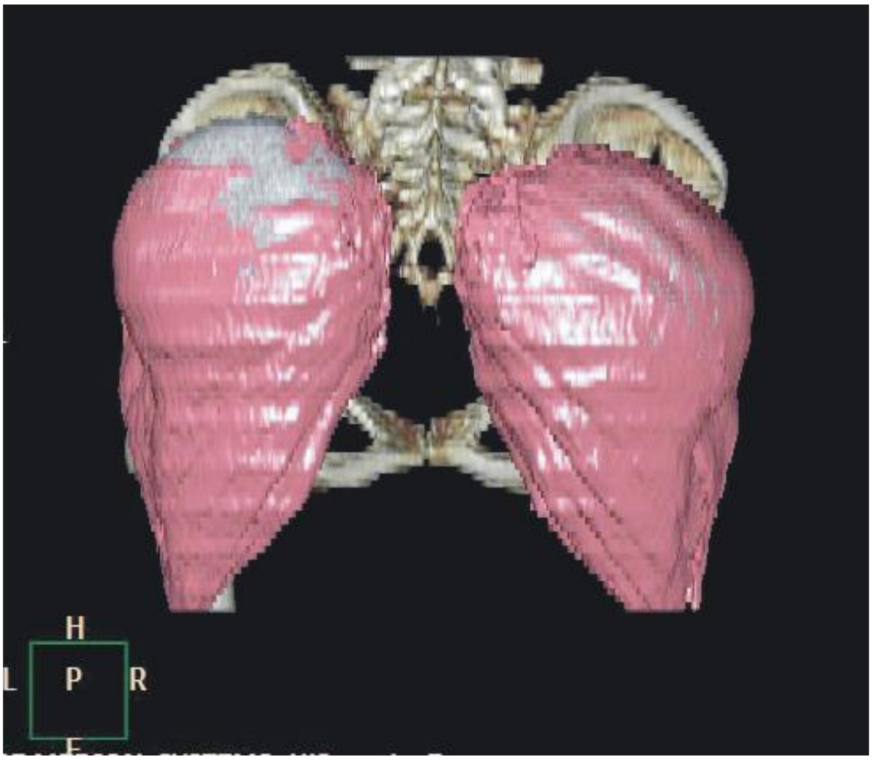



Figure 4- Superficial dissection and muscle rupture.

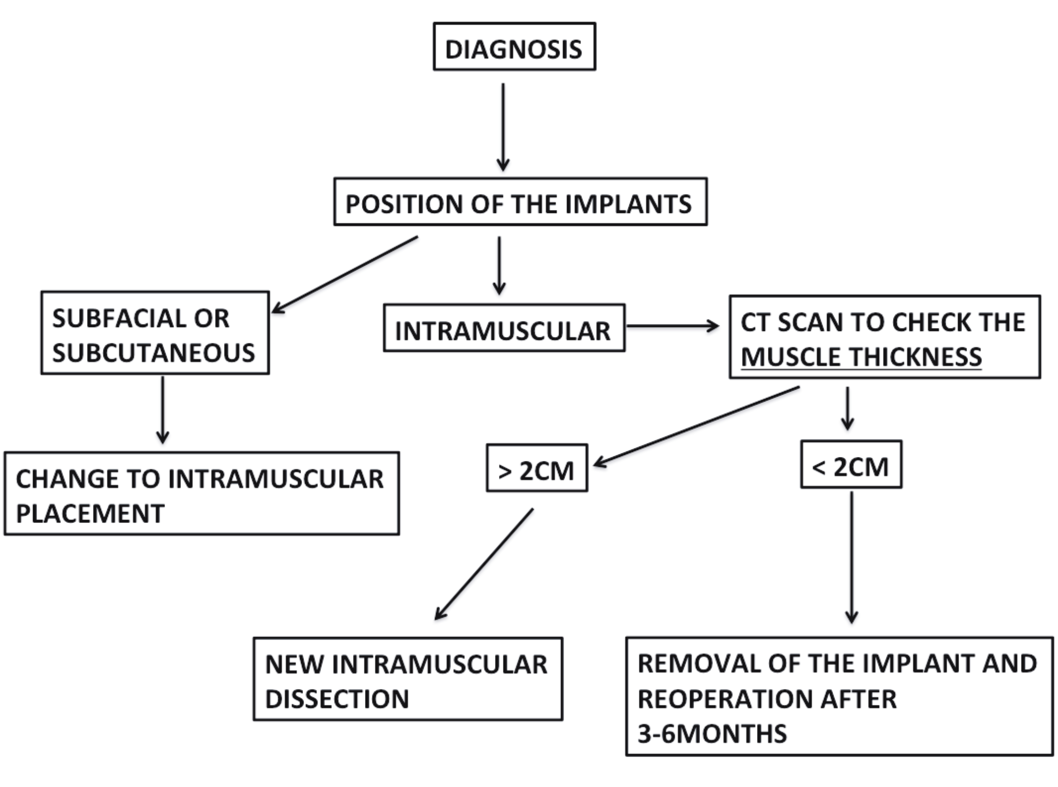



Figure 5-Treatment algorithm


Figure 6- Ct Scan after 3 months of secondary surgery: fibrosis of the subcutaneous layer corresponding to the superficial fibrous capsule, and intramuscular gluteal implants.


Figure 7- Ct Scan: Treatment failure on the right side. The implant is intramuscular at left and over the gluteus maximus muscle at right.


Figure 8- Ct Scan: Subcutaneous placement of the implants. Presence of seroma secondary to mycobacterial infection.

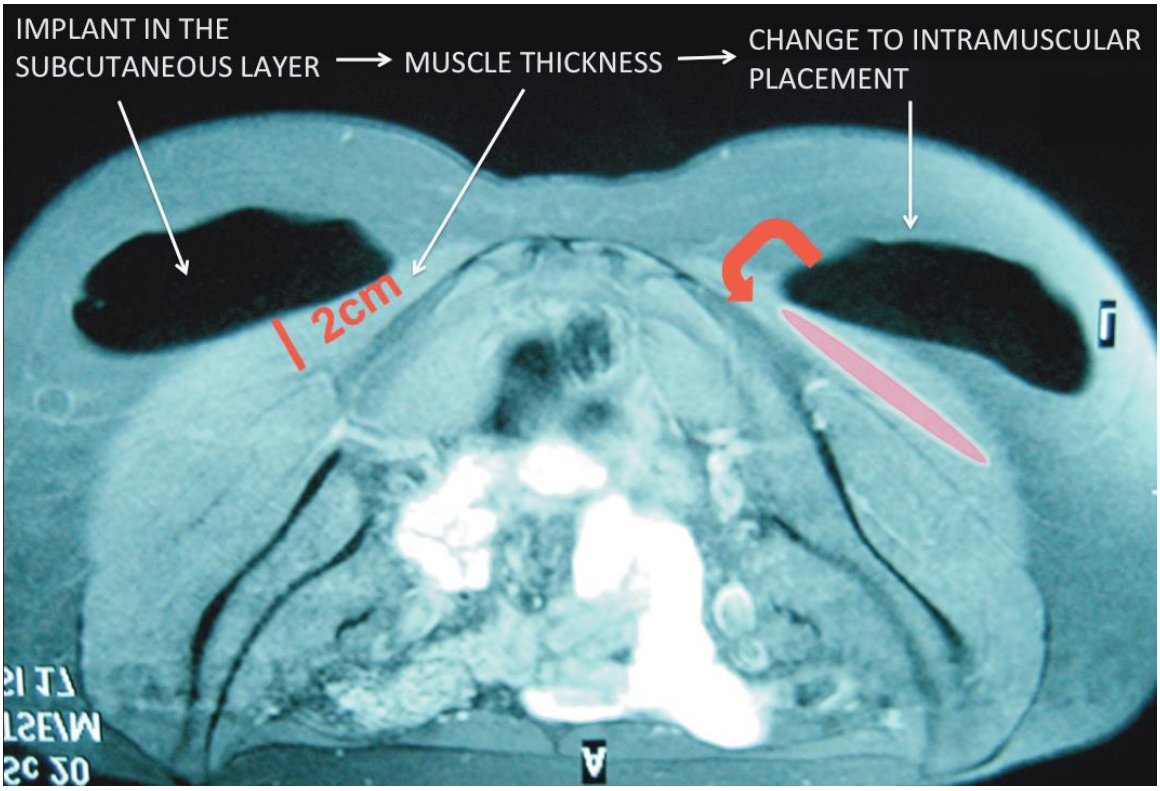


Figure 9- MRI evaluation and treatment.

Figure 10- 20 years old woman 240cc round base implants located in the subcutaneous layer. The patient main complain was visible implants.

Figure 11- 20 years old woman 240cc round base implants located in the subcutaneous layer. The patient main complain was visible implants.

Figure 12- 20 years old woman 240cc round base implants located in the subcutaneous layer. The patient main complain was visible implants.

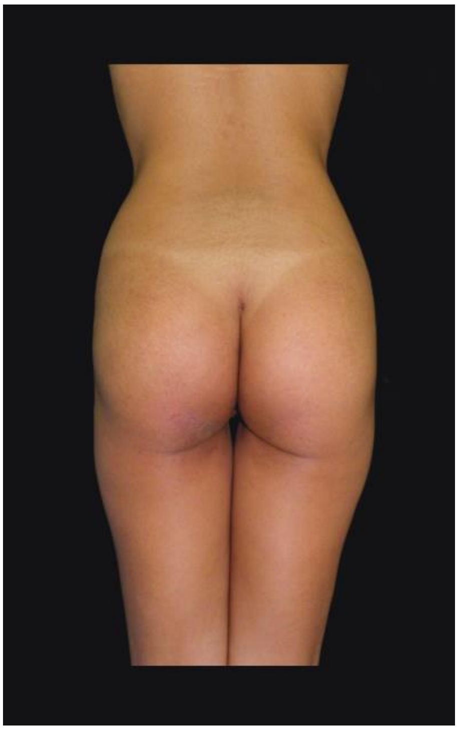


Figure 13- 20 years old woman, 18 months post operative. Oval base implants 300cc, intramuscular placement.

Figure 14- 20 years old woman, 18 months post operative. Oval base implants 300cc, intramuscular placement.

Figure 15- 20 years old woman, 18 months post operative. Oval base implants 300cc, intramuscular placement.

**Tables:**

Table 1- CT scan results

| POSITION | N (GLUTEUS) | MUSCLE THICKNESS(cm)* | TREATMENT | |
|---|---|---|---|---|
| | | | New intramuscular dissection | Implant removal |
| SUBCUTANEOUS | 12 (25.5%) | 3.7 (2.7 – 4.8) | 12 | 0 |
| SUBFASCIAL | 2 (4.2%) | 3.6 (3.4 – 3.9) | 2 | 0 |
| PARTIALLY INTRAMUSCULAR | 33 (70.2%) | 2.5 (1.2 – 3.7) | 27 | 6 |
| TOTAL | 47 | 3.2 (1.2 – 4.8) | 41 (87.2%) | 6 (12.7%) |

*Values are presented as average (minimum-maximum)

Table 2- Complications

| COMPLICATION | N | TREATMENT |
|---|---|---|
| DEHISCENCE | 13 (27.6%) | Second intention healing |
| SEROMA (SUPERFICIAL POCKET) | 5 (10.6%) | Needle aspiration |
| INFECTION | 1 (2.1%) | antibiotic therapy (outpatient) |
| RECURRENCE OF DISPLACEMENT | 1 (2.1%) | Implant removal |
| TEMPORARY SCIATIC PAIN | 2 (4.2%) | B complex vitamins and corticosteroids |
| TOTAL | 22 (46.8%) | |

**APÊNDICE G -** Anatomical and phisiological evaluationof the gluteus maximus muscle after augmentation gluteoplasty using silicone implants - Sexto artigo aceito para publicação

**Accept in June, 27th 2014.**
**PLASTIC AND RECONSTRUCTIVE SURGERY**
**ISSN:** 0032-1052
**Online ISSN:** 1529-4242
**Frequency:** 12 issues per year
**Ranking:** 13 of 198 in Surgery
**Impact Factor:** 3.535

## ANATOMICAL AND PHYSIOLOGICAL EVALUATION OF THE GLUTEUS MAXIMUS MUSCLE AFTER AUGMENTATION GLUTEOPLASTY USING SILICONE IMPLANTS

**FERNANDO SERRA, M.D**.-Plastic Surgery Staff, Pedro Ernesto University Hospital, Rio de Janeiro State University, Brazil.

**JOSE HORACIO ABOUDIB, M.D**. -Assistant Professor, Chief of the Plastic Surgery Service, Pedro Ernesto University Hospital, Rio de Janeiro State University, Brazil.

**JOSE INACIO SALLES NETO, Ph.D**.-Coordinator of the Neuromuscular Research Laboratory, Brazilian Institute of Traumatology and Orthopedics (INTO), Rio de Janeiro, Brazil.

**VICTOR RODRIGUES AMARAL COSSICH M.S.** Researcher of the Neuromuscular Research Laboratory, Brazilian Institute of Traumatology and Orthopedics (INTO), Rio de Janeiro, Brazil.

**NÁDIA CRISTINA PINHEIRO RODRIGUES, Ph.D**.-Adjunct professor of Epidemiology and Biostatistics, Department of Information Technology, Rio de Janeiro State University, Brazil.

**KATIA FUHRO DE OLIVEIRA** -Nutrition Division Staff, Pedro Ernesto University Hospital, Rio de Janeiro State University, Brazil.

**RUY GARCIA MARQUES, M.D., Ph.D.**-Associate Professor, Department of General Surgery, Rio de Janeiro State University, Brazil

From the Post-graduate Program in Physiopathology and Surgical Sciences – Rio de Janeiro State University, Brazil.

Acknowledgments:

JULIANA NOGUEIRA SIQUEIRA, M.D.

Radiology Staff, Quinta D'Or Hospital, Rio de Janeiro, Brazil.

**DISCLOSURES:**

There was no external funding for this study. The authors have no financial interest or commercial association with any of the subject matter or products mentioned in this article. The authors declare that no competing financial interests exist with regard to the present article.

**ABSTRACT** Background- The gluteal muscles have been very important throughout the evolution of mankind for the adoption of the bipedal posture. Over the past 15 years, the intramuscular technique has become popular and has been improved, with enhanced results and reduced levels of postoperative complications. The insertion of gluteal implants within the musculature may be an intrinsic compression factor of these muscles. The objective of the present study was to evaluate the gluteus maximus function and its variation over a 12-month period after the insertion of the implant. Methods- This was a prospective controlled clinical study. All subjects were female patients, with anthropometric characteristics and body mass index (BMI) within preset limits in order to establish similar groups. isokinetic test gluteus CT scans and clinical nutritional assessment were conducted in four stages during the study period: preoperatively and 3, 6, and 12 months after surgery. Results- The study group presented 6.14% muscle atrophy to the left and 6.43% muscle atrophy to the right after the procedure. Muscle strength presented differences in hip flexion and adduction tests. Conclusions- The gluteus maximus muscle presents atrophy secondarily to gluteal augmentation surgery with implants. Variations in gluteus maximus muscle strength should not be attributed primarily to the surgical procedure or to the implants, but physiological and multifactorial variations should also be considered. Strength and volume variations did not show a significant correlation. Gluteal augmentation with implants was effective in improving the WHR, as well as in changing the anthropometric pattern from android to gynoid. LEVEL OF EVIDENCE: PROGNOSTIC/RISK STUDIES I

KEY-WORDS – Gluteoplasty; gluteal; implants; prosthesis; isokinetic.

## BACKGROUND

The gluteal muscles have been very important throughout the evolution of mankind. Among the anatomical changes necessary for the adoption of the bipedal posture, the development of the gluteal muscle was crucial to maintain the upright posture and stabilize the pelvis.[1] However, from the aesthetic point of view, the first records of the enhancement of this anatomical region are the Venus de Milo (IV-III century BC) and Aphrodite of Calipigia (200 AC).[2] Currently, the gluteal region is considered to be of great aesthetic importance, as shown by the growing interest of the population in undergoing gluteoplasty surgery.[3]

Gonzáles Ulloa, from Mexico, was the surgeon who led to the anthropometric study of the region, developing specific implants for the buttocks.[4] The subcutaneous and submuscular techniques used for this purpose had some limitations.[5-7] However, in 1996, an intramuscular technique for buttock augmentation with implants was developed in Mexico.[8] In this technique, implants are covered by the gluteus maximus along its entire surface, so that they are not visible or palpable. Over the past 15 years, this technique has become popular and has been improved, it was standardized, the indications and the anatomical landmarks were defined. [3,5,9] Therefore the results were improved and reduced levels of postoperative complications.[10-12]

Until then, the use of intramuscular implants was limited to the treatment of neuromuscular diseases using intramuscular electrodes for muscle stimulation and experimental surgeries, with small volume implants being used.[13,14] Some studies have compared gluteoplasty techniques by evaluating the postoperative outcome,[5,11,15] but publications reporting complications have not evaluated the anatomical or functional behaviors of the muscles.[12,16]

Striated skeletal muscles are highly susceptible to atrophy and apoptosis injury secondary to external pressure.[17-20] The insertion of gluteal implants within the musculature may be an intrinsic compression factor of these muscles, also acting in synergism with compressive external factors. Intramuscular dissection divides the muscle into two flaps, superficial and deep flaps, which may compromise its contractile capability.

The objective of the present study was to evaluate the gluteus maximus volume and its variation over a 12-month period after the insertion of the implant, assessing the gluteus muscle strength, correlating it to the volume of the gluteus maximus muscle over the same period of time, carrying out anthropometric assessment of patients candidates for surgery, and verifying changes that occurred after gluteal augmentation surgery with implants.

## METHOD

This was a prospective controlled clinical study which was approved by the Board of Ethics in Research of Brazil under number 0011.0.305.305-10. All subjects voluntarily participated in this study and were patients from the Plastic Surgery outpatient clinic of Pedro Ernesto University Hospital, State University of Rio de Janeiro, Brazil. All subjects were female patients, ranging in age from 19-50 years, with anthropometric characteristics and body mass index (BMI) within preset limits in order to establish similar groups. (Table 1)

Study group – 22 women candidates for gluteal augmentation with implants were selected to participate in the study according to the inclusion and exclusion criteria. (Table 1) Control group – 22 women candidates for breast augmentation were selected to participate in the study according to the inclusion and exclusion criteria. (Table 1)

All patients (study group and control group) – abstained from exercise during the first 3 months following the surgical procedure for full recovery.

Evaluations were conducted in four stages during the study period: preoperatively and 3, 6, and 12 months after surgery. In each stage, the isokinetic test was applied, gluteus CT scans were taken, and clinical nutritional assessment was performed.

Clinical nutritional assessment

A nutritionist clinically assessed the patients, checking mass, height, body mass index, waist circumference, hip circumference, body fat percentage, and body fat distribution pattern defined by the comparison of android and gynoid fat.[22,23]

CT scan

CT scans were taken at the Radiology Service of Pedro Ernesto University Hospital, using a G.E. CT Hi speed® scanner (General Electric, Milwaukee, WI-USA, 1999), with spiral acquisition and 3 mm slices.

Three-dimensional reconstruction (3D) and muscle volumetry were carried out at the Quinta D'Or Hospital, Rio de Janeiro, Brazil, using the Extended Brilliance Workspace software was used (V3.5.0 2250, 12-Apr-2007, Philips Medical Systems – Netherland). (Figure 1)

The volume difference variable was created (Vol. Diff.) by subtracting the volume of the gluteus maximus muscle at 3, 6 or 12 months after surgery from the preoperative muscle volume for the right and left sides.

Example:

Right Side Volumetric Difference at 3 months = right side muscle volume at three months – right side preoperative muscle volume.

This variable was used to compare gluteus maximus development between groups.

Isokinetic testing

Muscle strength was assessed at the Neuromuscular Research Laboratory of the National Institute of Traumatology and Orthopedics (INTO) using the CSMI Humac Norm® isokinetic dynamometer (Stoughton, MA – U.S.A. – 2008) in order to apply the isokinetic dynamometer test during hip flexion/extension and adduction/abduction.

Speeds of 30 o/s and 60 o/s were applied because they are the slower speeds allowed by the dynamometer and thus register the greatest forces of contraction. Patients underwent the familiarization test and then performed five-repetition maximum, recording the best performance index for each speed. Maximum torque measurements were taken on the dominant side, upon information of the side that would be used to kick a ball to hit an area on the wall.[24]

The strength difference variable was created following the same pattern as the volume difference variable. This variable was used to compare the development of the gluteus maximus strength between the study and control groups.

Surgical technique

The intramuscular technique was used to insert the implants.[3] The gluteus maximus was dissected using two blunt dissectors, reducing muscle injury. The gluteal implant was inserted into the gluteus maximus muscle to a depth ranging from 2 to 2.5 cm[25] (Figure 2).

Cohesive gel implants (Silimed®) with oval base, smooth surface and 350 $cm^3$ and 400 $cm^3$ volume were used.

Statistical analyses

Data were analyzed considering the distribution mode by applying the Shapiro-Wilk test. Normal distribution data were analyzed by the Student t-test. Non-Gaussian distribution data were analyzed by nonparametric tests, i.e., the Wilcoxon test for paired data and the Mann-Whitney test for unpaired data.

The analyses were performed with the aid of the R Software, version 3.0.2, with the level of significance set at 5%.

## RESULTS

Table 2 presents a comparative analysis between the study and control groups, considering age and nutritional assessment. Waist and hip measurements and the waist-hip ratio (WHR) were compared among the subjects of the same group and between groups before and after the surgical procedure, as shown in Figure 3.

Body fat distribution patterns were classified as android in six patients from the study group, and as gynoid in the remaining patients of both groups. After the surgical procedure, the classification of the six patients with an android pattern changed to the gynoid pattern, while all other patients continued to have a gynoid pattern of body fat distribution.

Considering the preoperative volume, the study group presented 6.14% muscle atrophy to the left and 6.43% muscle atrophy to the right after a period of 12 months following the procedure (Figure 4).

The volume difference variable (Vol. Diff.) was applied to compare the development of the gluteus maximus muscle between groups, showing differences in all stages of the survey (Table 3).

Over a 12-month period, muscle strength development presented differences in hip flexion when compared to the preoperative values in both groups, when analyzed separately at a speed of 30 o/sec. The remaining tested movements showed no changes (Table 4). In the study group, the same analysis in the isokinetic test at 60 o/s revealed force increase during adduction (Table 5).

The strength difference variable was used to compare the development of gluteus maximus muscle strength between the control and the study groups (Tables 6 and 7).

At 12 months after the surgical procedure, statistical analysis did not show a significant correlation between the volume difference variable and the strength difference variable, except for the adduction isokinetic test at 60 $^{o}$/s, with a moderate positive correlation in the study group (Figure 5).

## DISCUSSION

The sample selection reflects the profile of patients candidates for gluteal augmentation, e.g., eutrophic women, predominantly in the third and fourth decade of life. The control group is selected in such a way as to consist of patients similar to those of the study group, considering body mass characteristics and the proportion between lean body mass and body fat percentage. The main difference between the groups is the aspiration to have breast or gluteal augmentation. In this group, the inclusion of women who would undergo another surgical procedure was important by forcing the patients to abstain from exercise during the same period of time in both groups. The intramuscular technique was used because it induces a lower rate of complications than the others.[26] Muscle plasticity and changes in volume and strength of striated skeletal muscle secondary to disuse have been reported previously.[27,28]

Some anthropometric parameters such as waist and hip circumferences are important health indicators.[29,30] The WHR is very important for body aesthetics, as pointed out by Singh.[31] The importance of WHR values close to 0.7 goes beyond cultural and ethnic factors and has been identified in several cultures throughout human history .[31] The sculpture of Venus de Milo, with a WHR of 0.68, is an example of this universally accepted beauty concept.[32] WHR values close to 0.7 indicate healthier women, less inclined to the development of cardiovascular diseases and with greater reproductive potential during pregnancy and birth.[31] Women with these characteristics are more attractive to the opposite sex, presenting better results in the preservation and propagation of the genetic heritage.[31]

Patients candidates for gluteal augmentation show higher WHR (average – 0.76) when compared to those with no intention to undergo surgery (average – 0.71). The search for this proportion can prevent patient dissatisfaction during the postoperative period. The surgical procedure has proved to be effective for changing the WHR. The WHR does not take into consideration if the shape is in front, back or lateral view, the influence of the buttocks projection and the hip width separately should be better studied.

Body fat distribution patterns, classified as android and gynoid, are closely related to the WHR, with the android pattern concentrating fat on the trunk and arms, and the gynoid pattern in the legs and pelvis.[23] In the present study, the change in the classification from android to gynoid in all cases after the procedure showed the ability of this procedure to improve body contour, but we don't believe in health changes secondary to the operation.

CT scans are used for 3D reconstruction and the bone and soft tissue volumetry often shows good results.[25,33,34] The isolation of muscle tissue by the difference in tissue density prevents manual selection and variations caused by human error. In the present study, the muscle showed atrophy when submitted to the surgical procedure for the insertion of implants; however, the chart showed an upward curve three months after surgery (the time when the patient can practice exercise), revealing a tendency to recovery. The use of smaller implants has caused less muscle atrophy. [25]The difference in implant volume can be a determining factor for muscle atrophy. and should be further investigated in future studies.

The skeletal striated muscle tissue presents constant renewal that will depend on the relationship between the synthesis and degradation of proteins in its interior.[28] Sato et al.[28] demonstrated inactivity as an adjuvant in losing muscle mass. Breuls et al.[35] have demonstrated in vitro the susceptibility to muscle cell injury secondary to compression, indicating the role of orthoses and prostheses as additional factors in this mechanism of cell injury. Several experimental studies have reported muscle tissue injury in mice resulting from external compression. [17-20,36] Our findings showed that muscle atrophy also occurs in the gluteus maximus muscle when implants are inserted in the fiber, in agreement with literature data suggesting that, in atrophy, compression is a factor caused by cell deformation.[35] The gluteal maximus atrophy have had no impact on the muscle function in this study once there was no changes in the strength during the extension and abduction tests.

The isokinetic test is of great importance for the analysis of muscle performance.[37] Speeds of 30, 60, 90, 120, and 180 °/s are provided by the equipment. Considering the relationship between force vs. contraction speed, the lowest speed will allow greater contraction strength.[37,38]

Speeds of 30 o/s and 60 o/s were selected here in order to achieve force values closer to the isometric ones, measuring the maximum active torque.[37,38]

Bartlett et al.[39] have determined by electromyography the function of the gluteus maximus muscle in several situations such as walking, running, jumping, and climbing, as well as in secondary actions to stabilize the trunk and pelvis. The isokinetic test was used here to evaluate four different movements (adduction, abduction, flexion and extension), considering the wide function of the muscle in question, in an attempt to observe changes that could occur in it. In the study group, muscle strength evaluation revealed a decrease of strength during flexion movements at 30 o/s at all time points evaluated. The primary concentric action of the gluteus maximus muscle is the extension of the thigh;[39] therefore, during flexion, the gluteal muscle acts as an antagonist.[40] In the control group, the observation of force decrease in the same flexion test led us to believe that this alteration is caused by muscle inactivity, probably related to the muscles of the anterior part of the thigh and hip primarily involved in flexion.[41] Forces acting on the movement of the hip joint work together, having as a resultant the harmonious interaction between the antagonist and the agonist muscle groups for each movement.[40,42] A disharmony in this relationship, causing excessive anterior or posterior force on the hip joint, can lead to instability and injuries.[40]

Our findings, demonstrating an increase in flexion strength with no change in extension strength, raised the possibility of future injury to the hip joint. Therefore, these patients should be long-term monitored with isokinetic tests for a better joint evaluation.

The isokinetic test is used to evaluate the agonist muscle strength in a particular joint movement.[37] In the study group, the increased strength in adduction may have been due to the increased strength in the adductor muscles, to a reduction in strength of the abductor muscles or to both. The fact that the surgical procedure does not interfere with the adductor muscles leads us to conclude that the main reason for this change would be a decrease in gluteal muscle strength in its role as antagonist, however the isokinetic test does not evaluate the antagonistic muscle action. The abduction test, in which the buttocks act as agonists, showed no changes.

The buttock augmentation surgery and the permanence of the implant within the gluteus maximus muscle do not interfere with the physiological strength of this muscle, which is influenced by several factors such as inactivity, stretching, training etc.[27,28,43,44] The strength preservation may be the result of using blunt instruments for dissection, a procedure in which the muscle is not incised, in agreement with the report of Socolovsky & Masi [45] who have shown that gluteal approaches without the incision of the muscle fibers produce less surgical trauma and better recovery.

The relationship between muscle strength and hypertrophy has been previously investigated and varies depending on several factors.[43,44,46] The results shows that muscle strength and volume do not vary jointly. Several studies have shown that the type of exercise will affect quantitatively the increase of muscle mass and strength gain.[43,47-49] In the present study, patients started to practice exercise 3 months after the surgical procedure, exercising according to their preference, with various types, intensities and periods of training.

Lundberg et al.[49] demonstrated that several types of training not only change the volume and strength of muscle, but also change the relationship between the two variables. Ballak et al.[50] demonstrated that the end product of muscle strength depends on the interaction among several factors such as muscle mass, amount and length of fibers, distribution of fiber types, and muscle tension. The torque generated by limb length can also influence strength.[51]

This is the first study on gluteus maximus muscle function after gluteal augmentation and constitutes the first phase of a more complex and comprehensive research project involving several aspects such as gluteal sensitivity, importance of the implant size, proprioception, change in quality of life, sexual function, and satisfaction with the surgical procedure.

## CONCLUSION

The gluteus maximus muscle presents atrophy secondarily to gluteal augmentation surgery with implants at 12 months after the surgical procedure.

During this period, variations in gluteus maximus muscle strength should not be attributed primarily to the surgical procedure or to the implants, but physiological and multifactorial variations should also be considered. Strength and volume variations did not show a significant correlation within the study period.

Patients candidates for gluteal augmentation have a smaller buttock volume, a higher WHR value and an android pattern of body fat distribution more frequently than patients who are not candidates for this procedure. Gluteal augmentation with implants was effective in improving the WHR, as well as in changing the anthropometric pattern from android to gynoid.

## REFERENCES


1. Morimoto N, Zollikofer CP, Ponce de León MS. Shared human-chimpanzee pattern of perinatal femoral shaft morphology and its implications for the evolution of hominin locomotor adaptations. PLoS One. 2012;7(7):e41980.

2. de la Peña JA, Rubio OV, Cano JP, Cedillo MC, Garces MT. History of gluteal augmentation. Clin Plast Surg. 2006;33(3):307-319.

3. Aboudib JH, Serra F, de Castro CC. Gluteal augmentation: technique, indications, and implant selection. Plast Reconstr Surg. 2012;130(4):933-935.

4. González-Ulloa M. Gluteoplasty: A ten-year report. Aesthetic Plast Surg. 1991;15(1):85-91.

5. Mendieta CG. Gluteoplasty. Aesthet Surg J. 2003;23(6):441-455.

6. Robles JM, Tagliapietra JC, Grandi MA. Gluteoplastia de aumento: implante submuscular. Cir Plast Iberolatinoam. 1984;10(4):365-375.

7. Serra F, Aboudib JH, Cedrola JP, de Castro CC. Gluteoplasty: anatomic basis and technique. Aesthet Surg J. 2010;30(4):579-592.

8. Vergara R, Marcos M. Intramuscular gluteal implants. Aesthetic Plast Surg. 1996;20(3):259-262.

9. Gonzalez R. Augmentation gluteoplasty: the XYZ method. Aesthetic Plast Surg. 2004;28(6):417-425.

10. Serra F, Aboudib JH, Marques RG. Reducing wound complications in gluteal augmentation surgery. Plast Reconstr Surg. 2012;130(5):706e-713e.

11. Mofid MM, Gonzalez R, de la Peña JA, Mendieta CG, Senderoff DM, Jorjani S. Buttock augmentation with silicone implants: a multicenter survey review of 2226 patients. Plast Reconstr Surg. 2013;131(4):897-901.

12. Bruner TW, Roberts TL 3rd, Nguyen K. Complications of buttocks augmentation:

diagnosis, management, and prevention. Clin Plast Surg. 2006;33(3):449-466.

13. Xaymardan M, Gibbins JR, Zoellner H. Adipogenic healing in adult mice by implantation of hollow devices in muscle. Anat Rec. 2002;267(1):28-36.

14. Chae J, Hart R. Intramuscular hand neuroprosthesis for chronic stroke survivors. Neurorehabil Neural Repair. 2003;17(2):109-117.

15. Harrison D, Selvaggi G. Gluteal augmentation surgery: indications and surgical management. J Plast Reconstr Aesthet Surg. 2007;60(8):922-928.

16. Alperovich M, Schreiber JE, Singh NK. Infection after augmentation gluteoplasty in a pregnant patient. Aesthet Surg J. 2007;27(6):622-625.

17. Linder-Ganz E, Engelberg S, Scheinowitz M, Gefen A. Pressure-time cell death threshold for albino rat skeletal muscles as related to pressure sore biomechanics. J Biomech. 2006;39(14):2725-2732.

18. Linder-Ganz E, Gefen A. Mechanical compression-induced pressure sores in rat hindlimb: muscle stiffness, histology, and computational models. J Appl Physiol. 2004;96(6):2034-2049.

19. Siu PM, Tam EW, Teng BT, Pei XM, Ng JW, Benzie IF, Mak AF. Muscle apoptosis is induced in pressure-induced deep tissue injury. J Appl Physiol. 2009;107(4):1266- 1275.

20. Stekelenburg A, Oomens CW, Strijkers GJ, Nicolay K, Bader DL. Compression- induced deep tissue injury examined with magnetic resonance imaging and histology. J Appl Physiol. 2006;100(6):1946-1954.

21. Cuenca-Guerra R, Quezada J. What makes buttocks beautiful? A review and classification of the determinants of gluteal beauty and the surgical techniques to achieve them. Aesthetic Plast Surg. 2004;28(5):340-347.

22. Jellife DB. The assessment of the nutritional status of the community (with special reference to field surveys in developing regions of the world). Monogr Ser World Health Organ. 1966;53:3-271.

23. Cao Y, Zhang S, Zou S, Xia X. The relationship between endogenous androgens and body fat distribution in early and late postmenopausal women. PLoS One. 2013;8(3):e58448.

24. van Cingel EHR, Kleinrensink GJ, Rooijens PPGM, Uitterlinden EJ, Aufdemkampe G, Stoeckart R. Learning effect in isokinetic testing of ankle invertors and evertors. Isokinet Exerc Sci. 2001;9(1):171-177.

25. Serra F, Aboudib JH, Marques RG. Intramuscular technique for gluteal augmentation: determination and quantification of muscle atrophy and implant position by computed tomographic scan. Plast Reconstr Surg. 2013;131(2):253e-259e.

26. Flores-Lima G, Eppley BL, Dimas JR, Navarro DE. Surgical pocket location for gluteal implants: a systematic review. Aesthetic Plast Surg. 2013;37(2):240-245.

27. Trappe S, Costill D, Gallagher P, Creer A, Peters JR, Evans H, Riley DA, Fitts RH. Exercise in space: human skeletal muscle after 6 months aboard the International Space Station. J Appl Physiol (1985). 2009;106(4):1159-1168.

28. Sato S, Shirato K, Tachiyashiki K, Imaizumi K. Muscle plasticity and β2-adrenergic receptors: adaptive responses of β2-adrenergic receptor expression to muscle hypertrophy and atrophy. J Biomed Biotechnol. 2011;2011:729598.

29. Olinto MT, Nacul LC, Gigante DP, Costa JS, Menezes AM, Macedo S. Waist circumference as a determinant of hypertension and diabetes in Brazilian women: a population-based study. Public Health Nutr. 2004;7(5):629-635.

30. Klein S, Allison DB, Heymsfield SB, Kelley DE, Leibel RL, Nonas C, Kahn R. Waist circumference and cardiometabolic risk: a consensus statement from Shaping America's Health: Association for Weight Management and Obesity Prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. Am J Clin Nutr. 2007;85(5):1197–1202.

31. Singh D. Universal allure of the hourglass figure: an evolutionary theory of female physical attractiveness. Clin Plast Surg. 2006;33(3):359-370.

32. Hong YJ, Park HS, Lee ES, Suh YJ. Anthropometric analysis of waist-to-hip ratio in Asian women. Aesthetic Plast Surg. 2009;33(2):185-190.

33. Kestin LL, Jaffray DA, Edmundson GK, Martinez AA, Wong JW, Kini VR, et al. Improving the dosimetric coverage of interstitial high-dose-rate breast implants. Int J Radiat Oncol Biol Phys. 2000;46(1):35-43.

34. Papageorgiou KI, Mancini R, Garneau HC, Chang SH, Jarullazada I, King A, et al. A three-dimensional construct of the aging eyebrow: the illusion of volume loss. Aesthet Surg J. 2012;32(1):46-57.

35. Breuls RG, Bouten CV, Oomens CW, Bader DL, Baaijens FP. Compression induced cell damage in engineered muscle tissue: an in vitro model to study pressure ulcer aetiology. Ann Biomed Eng. 2003;31(11):1357-1364.

36. Schwartz LM. Atrophy and programmed cell death of skeletal muscle. Cell Death Differ. 2008;15(7):1163-1169.

37. Aquino CF, Vaz D, Brício RS, Silva PLP, Ocarino JM, Fonseca ST. A tili ac o da dinamometria isocin tica nas ie ncias do esporte e eabilitac o. ev Bras Cir Mov. 2007;15(1):93-100.

38. Reichard LB, Croisier JL, Malnati M, Katz-Leurer M, Dvir Z. Testing knee extension and flexion strength at different ranges of motion: an isokinetic and eletromyographic study. Eur J Appl Physiol. 2005;95(4):371-376.

39. Bartlett JL, Sumner B, Ellis RG, Kram R. Activity and functions of the human gluteal muscles in walking, running, sprinting, and climbing. Am J Phys Anthropol. 2014;153(1):124-131.

40. Lewis CL, Sahrmann SA, Moran DW. Anterior hip joint force increases with hip extension, decreased gluteal force, or decreased iliopsoas force. J Biomech. 2007;40(16):3725-3731.

41. Johnson R. Lumbo-pelvic angular kinematics in youth baseball pitchers after a simulated game. Br J Sports Med. 2014;48(7):613.

42. Lewis CL, Sahrmann SA, Moran DW. Effect of position and alteration in synergist muscle force contribution on hip forces when performing hip strengthening exercises. Clin Biomech (Bristol, Avon). 2009;24(1):35-42.

43. Erskine RM, Fletcher G, Folland JP. The contribution of muscle hypertrophy to strength changes following resistance training. Eur J Appl Physiol. 2014; 114(6):1239-1249.

44. Van Roie E, Delecluse C, Coudyzer W, Boonen S, Bautmans I. Strength training at high versus low external resistance in older adults: effects on muscle volume, muscle strength, and force-velocity characteristics. Exp Gerontol. 2013;48(11):1351-1361.

45. Socolovsky M, Masi GD. Exposure of the sciatic nerve in the gluteal region without sectioning the gluteus maximus: Analysis of a series of 18 cases. Surg Neurol Int. 2012;3:15.

46. Harber MP, Konopka AR, Undem MK, Hinkley JM, Minchev K, Kaminsky LA, et al. Aerobic exercise training induces skeletal muscle hypertrophy and age-dependent adaptations in myofiber function in young and older men. J Appl Physiol (1985). 2012;113(9):1495-1504.

47. Deley G, Laroche D, Babault N. Effects of electrical stimulation pattern on quadriceps force production and fatigue. Muscle Nerve. 2014; 49(5):760-763.

48. Barak Y, Ayalon M, Dvir Z. Spectral EMG changes in vastus medialis muscle following short range of motion isokinetic training. J Electromyogr Kinesiol. 2006;16(5):403-412.

49. Lundberg TR, Fernandez-Gonzalo R, Tesch PA. Exercise-induced AMPK activation does not interfere with muscle hypertrophy in response to resistance training in men. J Appl Physiol (1985). 2014;116(6):611-620.

50. Ballak SB, Degens H, de Haan A, Jaspers RT. Aging related changes in determinants of muscle force generating capacity: A comparison of muscle aging in men and male rodents. Ageing Res Rev. 2014;14C:43-55.

51. Baxter JR, Piazza SJ. Plantar flexor moment arm and muscle volume predict torque-generating capacity in young men. J Appl Physiol (1985). 2014;116(5):538-544.

FIGURES:

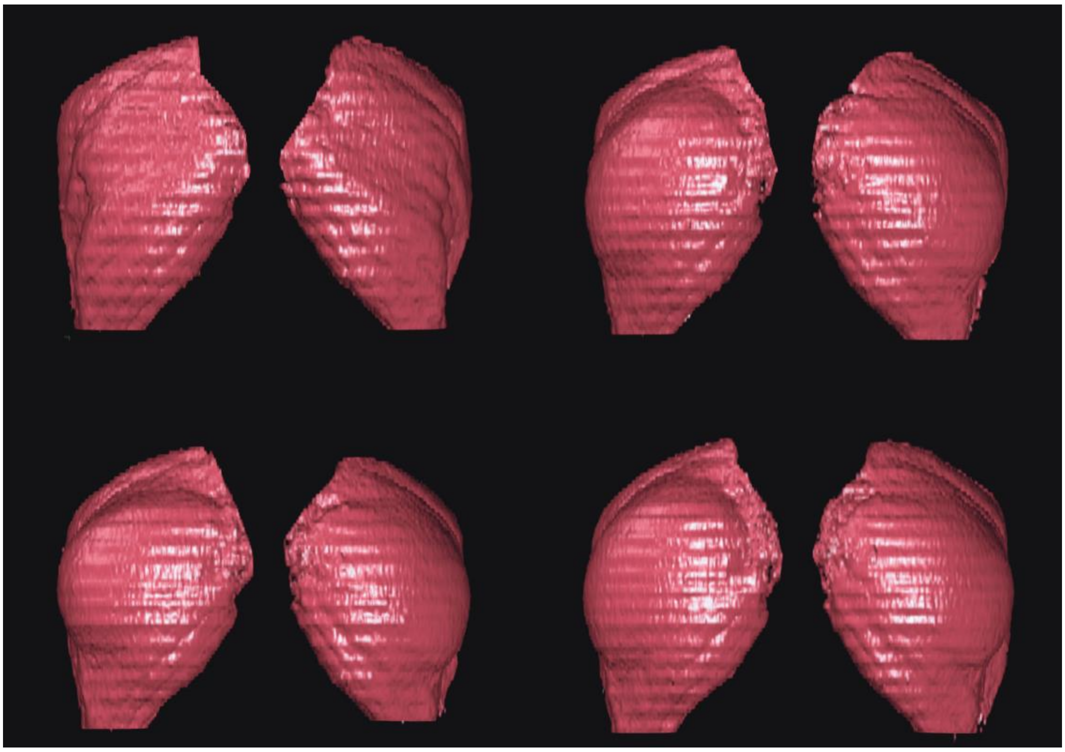


Figure 1 – CT scan and 3D gluteal reconstruction (Clockwise direction): pre- operative; after 3, 6, and 12 months of the surgical procedure.

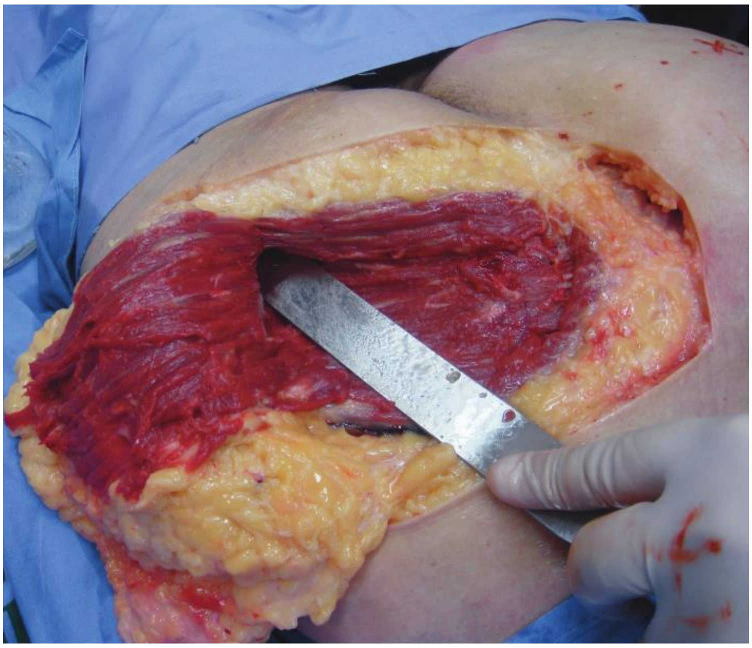


Figure 2 – Cadaver dissection: gluteal intramuscular pocket dissection, ranging from 2-2.5 cm in depth.

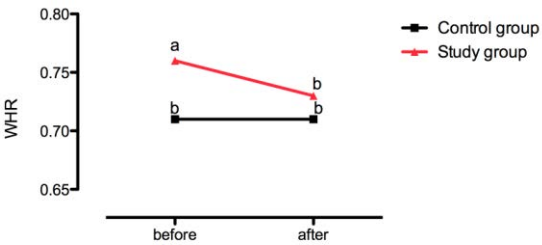



Figure 3 – The waist-to-hip ratio. Different letters represent statistical significance when comparing the means.

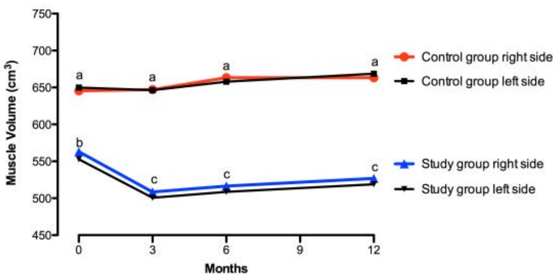



Figure 4 – Gluteus maximus muscle volumetry. Different letters represent statistical significance in the comparison between the means ($p < 0.05$). Control group n = 20; study group n = 22.

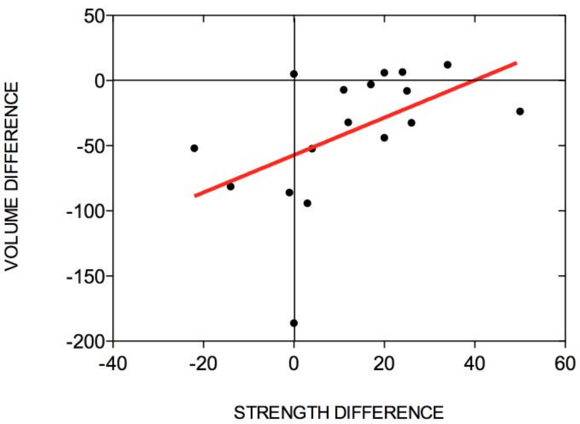



Figure 5 – Correlation between volume difference and strength difference in isokinetic testing at 60 ° / s after 12 months of operation. Study group, r = +0.5, p = 0.04.

TABLES:

**Table 1** – Sample selection

| INCLUSION CRITERIA | EXCLUSION CRITERIA |
|---|---|
| Women | Gluteal ptosis |
| IMC = 17,9 – 27.3 Kg/m$^2$ | Chronic diseases |
| Anthropometric analysis type II, III or IV (lack of volume and/or lack of projection). * | Arthropathies |
| | Pregnancy |
| | Use of corticosteroids |
| | Infections |
| | Claustrophobia |
| | Previous gluteus scar |

!
*!From:!*Cuenca-Guerra R, Quezada J. What makes buttocks beautiful? A review and classification of the determinants of gluteal beauty and the surgical techniques to achieve them. Aesthetic Plast Surg. 2004;28(5):340-347.*[21]

**Table 2** – Pre operative evaluation.

| | Age (years*) | BMI (Kg/m$^2$)* | Hip circumference (cm)* | Waist to hip ratio* | Body fat percentage * |
|---|---|---|---|---|---|
| **Study group (n=22)** | 32.9 (22-46) | 22.2 (17.9-27.3) | 94.8 (86-107) | 0.76 (0.68-0.85) | 23.6 (16-32.2) |
| **Control group (n=22)** | 27.9 (19-50) | 21.8 (18.6-25) | 96.4 (87.5-107) | 0.71 (0.61-0.8) | 24.8 (18.6-36.3) |
| ***p value*** | 0.01 | 0.54 | 0.33 | 0.0002 | 0.4 |

* Values presented as Mean (minimum-maximum)

**Table 3** – Comparison between groups of the volume difference variable.

| **Variable** | **Control Group*** | **Study Group*** | ***p* value** |
|---|---|---|---|
| Vol diff Left 3 months | 0.083 | -52.1 | 0.0004 |
| Vol diff Left 6 months | 8.06 | -46.6 | 0.0006 |
| Vol diff Left 12 months | 18.9 | -33.8 | 0.0012 |
| | | | |
| Vol diff Right 3 months | 5.77 | -54.6 | 0.0001 |
| Vol diff Right 6 months | 17.2 | -48.8 | 0.0001 |
| Vol diff Right 12 months | 17.7 | -36.2 | 0.0022 |

* Values presented as mean of the differences (cm$^3$).

**Table 4** – Isokinetic testing at 30º/s. Evaluation of each group separately.

| Isokinetic test | Study group comparison (Nm) | *p* value | Isokinetic test | Control group comparison (Nm) | *p* value |
|---|---|---|---|---|---|
| Aduçtion | Pre* x 3 months†<br>(101,3) (104,2) | 0,94 | aduçtion | Pre ◊x 3 months ‡<br>(117,8) (119,5) | 0,67 |
| Aduçtion | Pre x 6 months #<br>(101,3) (112,1) | 0,19 | aduçtion | Pre x 6 months ¥<br>(117,8) (117,8) | 0,9 |
| Aduçtion | Pre x 12 monthsΔ<br>(101,3) (112,4) | 0,97 | aduçtion | Pre x 12 months ß<br>(117,8) (118,8) | 0,18 |
| | | | | | |
| Abduction | Pre x 3 months<br>(59,8) (54,1) | 0,054 | abduction | Pre x 3 months<br>(64,6) (63,9) | 0,84 |
| Abduction | Pre x 6 months<br>(59,8) (56,2) | 0,14 | abduction | Pre x 6 months<br>(64,6) (63,8) | 0,86 |
| Abduction | Pre x 12 months<br>(59,8) (55,9) | 0,18 | abduction | Pre x 12 months<br>(64,6) (65,5) | 0,5 |
| | | | | | |
| Flexion | Pre x 3 months<br>(68,5) (62,7) | 0,028 | flexion | Pre x 3 months<br>(69,7) (66,8) | 0,26 |
| Flexão | Pre x 6 months<br>(68,5) (63,1) | 0,03 | flexion | Pre x 6 months<br>(69,7) (65,6) | 0,045 |
| Flexão | Pre x 12 months<br>(68,5) (62,3) | 0,006 | flexion | Pre x 12 months<br>(69,7) (69,0) | 0,4 |
| | | | | | |
| Extension | Pre x 3 months<br>(164,4) (152,3) | 0,09 | extension | Pre x 3 months<br>(177) (170,8) | 0,4 |
| Extension | Pre x 6 months<br>(164,4) (155,4) | 0,28 | extension | Pre x 6 months<br>(177) (164,7) | 0,08 |
| Extension | Pre x 12 months<br>(164,4) (154,2) | 0,057 | extension | Pre x 12 months<br>(177) (158,8) | 0,15 |

* Study group pre operative, n=22
† Study group 3 months, n=21
# Study group 6 months, n=20
Δ Study group 12 months, n=17

◊ Control group pre operative, n=22
‡ Control group 3 months, n=22
¥ Control group 6 months, n=20
ß Control group 12 months, n=16

**Table 5 – Isokinetic testing at 60º/s. Evaluation of each group separately.**

| Isokinetic test | Study group comparison (Nm) | *p* value | Isokinetic test | Control group comparison (Nm) | *p* value |
|---|---|---|---|---|---|
| Aduçtion | Pre* x 3 months† (86,0) (90,5) | 0,69 | aduçtion | Pre ◊ x 3 months ‡ (104,0) (103,5) | 0,92 |
| Aduçtion | Pre x 6 months # (86,0) (96,7) | 0,49 | aduçtion | Pre x 6 months ¥ (104,0) (103,6) | 0,90 |
| Aduçtion | Pre x 12 months Δ (86,0) (108,4) | 0,011 | aduçtion | Pre x 12 months ß (104,0) (106,2) | 0,42 |
| Abduction | Pre x 3 months (50,3) (47,9) | 0,44 | abduction | Pre x 3 months (61,0) (57,3) | 0,17 |
| Abduction | Pre x 6 months (50,3) (48,6) | 0,92 | abduction | Pre x 6 months (61,0) (55,5) | 0,11 |
| Abduction | Pre x 12 months (50,3) (53,8) | 0,96 | abduction | Pre x 12 months (61,0) (58,8) | 0,50 |
| Flexion | Pre x 3 months (53,7) (48,7) | 0,11 | flexion | Pre x 3 months (56,4) (54,3) | 0,26 |
| Flexion | Pre x 6 months (53,7) (51,7) | 0,59 | flexion | Pre x 6 months (56,4) (60,7) | 0,66 |
| Flexion | Pre x 12 months (53,7) (53,1) | 0,68 | flexion | Pre x 12 months (56,4) (56,3) | 0,42 |
| Extension | Pre x 3 months (138,4) (127,1) | 0,25 | extension | Pre x 3 months (152,3) (158,2) | 0,34 |
| Extension | Pre x 6 months (138,4) (142,0) | 0,98 | extension | Pre x 6 months (152,3) (155,4) | 0,76 |
| Extension | Pre x 12 months (138,4) (144,2) | 0,96 | extension | Pre x 12 months (152,3) (153,0) | 0,87 |

* Study group pre operative, n=22
† Study group 3 months, n=21
# Study group 6 months, n=20
Δ Study group 12 months, n=17

◊ Control group pre operative, n=22
‡ Control group 3 months, n=22
¥ Control group 6 months, n=20
ß Control group 12 months, n=16

**Table 6** – Comparison between groups of the strength difference variable at 30 $^{o}$/ s.

| **Variable (N)** | **Control Group*** | **Study group*** | ***p* value** |
|---|---|---|---|
| Strength diff.30 adu 3 months | 1,75 | 0,33 | 0,83 |
| Strength diff.30 adu 6 months | -0,52 | 8,3 | 0,27 |
| Strength diff.30 adu 12 months | 6 | 0,11 | 0,33 |
| Strength diff.30 abd 3 months | -0,65 | -6,04 | 0,22 |
| Strength diff.30 abd 6 months | -0,52 | -4,68 | 0,34 |
| Strength diff.30 abd 12 months | 2,66 | -4,76 | 0,16 |
| Strength diff .30 flex 3 months | -2,85 | -5,54 | 0,4 |
| Strength diff .30 flex 6 months | -5,31 | -4,81 | 0,88 |
| Strength diff .30 flex 12 months | -2,8 | -7,11 | 0,35 |
| Strength diff .30 ext 3 months | -6,2 | -11,27 | 0,6 |
| Strength diff .30 ext 3 months | -13,8 | -8,36 | 0,6 |
| Strength diff .30 ext 3 months | -14 | -16,88 | 0,81 |

* Values presented as mean of the diferences (Nm).

!

!

!
!
!
!
!
!
!

**Table 7** – Comparison between groups of the strength difference variable at 60 $^{o}$/ s.

| **Variable (N)** | **Control Group*** | **Study group*** | ***p* value** |
|---|---|---|---|
| Strength diff.60 adu 3 months | -0,5 | 2,59 | 0,7 |
| Strength diff.60 adu 6 months | -0,66 | 5 | 0,6 |
| Strength diff.60 adu 12 months | 7,35 | 12,29 | 0,62 |
| Strength diff.60 abd 3 months | -3,65 | -2,5 | 0,78 |
| Strength diff.60 abd 6 months | -5,77 | -0,35 | 0,29 |
| Strength diff.60 abd 12 months | -1 | 0,17 | 0,84 |
| Strength diff .60 flex 3 months | -2,85 | -5,54 | 0,43 |
| Strength diff .60 flex 6 months | -5,31 | -4,81 | 0,88 |
| Strength diff .60 flex 12 months | -2,8 | -7,11 | 0,35 |
| Strength diff .60 ext 3 months | 5,95 | -10,22 | 0,13 |
| Strength diff .60 ext 3 months | 2,55 | 0,15 | 0,84 |
| Strength diff .60 ext 3 months | 1,85 | 0,52 | 0,93 |

* Values presented as mean of the diferences (Nm).

!
!

**ANEXO A**- Depósito de pedido de patente

< Uso exclusivo do INPI >

CC pic

INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL PROTOCOLO GERAL
apgr 020130093983
3/12/2013 16:27 NPRJ
BR 20 2013 032668 8

lo para o protocolo | Espaço reservado para a etiqueta | Espaço reservado para o código QR

INPI INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL

**INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL**
**Sistema de Gestão da Qualidade**
**Diretoria de Patentes**

| DIRPA | Tipo de Documento: Formulário | DIRPA | Página: 1/3 |
|---|---|---|---|
| Título do Documento: **Depósito de Pedido de Patente** | | Código: FQ001 | Versão: 2 |
| | | Procedimento: DIRPA-PQ006 | |

**Ao Instituto Nacional da Propriedade Industrial:**
O requerente solicita a concessão de um privilégio na natureza e nas condições abaixo indicadas:

**1. Depositante (71):**

1.1 Nome: Universidade do Estado do Rio de Janeiro
1.2 Qualificação:
1.3 CNPJ/CPF: 33.541.014/0001-57
1.4 Endereço Completo: R São Francisco Xavier 524, SL 29F, Maracanã, Rio de Janeirc
1.5 CEP: 20550013
1.6 Telefone: 23340017 1.7 Fax:
1.8 E-mail: inovuerj@sr2.uerj.br

☐ continua em folha anexa

**2. Natureza:** ☐ Invenção ☒ Modelo de Utilidade ☐ Certificado de Adição

**3. Título da Invenção ou Modelo de Utilidade (54):**

Instrumento para Gluteoplastia

☐ continua em folha anexa

**4. Pedido de Divisão: do pedido Nº** **Data de Depósito:**

**5. Prioridade:** ☐ Interna (66) ☐ Unionista (30)

O depositante reivindica a(s) seguinte(s):

| País ou Organização do depósito | Número do depósito (se disponível) | Data de depósito |
|---|---|---|
| | | |
| | | |
| | | |

☐ continua em folha anexa

**INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL**
**Sistema de Gestão da Qualidade**
**Diretoria de Patentes**

| DIRPA | Tipo de Documento: Formulário | DIRPA | Página: 2/3 |
|---|---|---|---|
| Título do Documento: **Depósito de Pedido de Patente** | | Código: FQ001 | Versão: 2 |
| | | Procedimento: DIRPA-PQ006 | |

**6. Inventor (72):**

☐ Assinale aqui se o(s) mesmo(s) requer(em) a não divulgação de seus nome(s), neste caso não preencher os campos abaixo.

6.1 Nome: Fernando Serra Guimarães
6.2 Qualificação:
6.3 CPF: 07175694709
6.4 Endereço Completo: Rua de Paranhos Antunes 100, ap 106, Bl 1. Barra da Tijuca
6.5 CEP: 22620-300
6.6 Telefone: 91769718 6.7 FAX:
6.8 E-mail: fserragugmail.com

☐ continua em folha anexa

**7. Declaração de divulgação anterior não prejudicial.** ☐
Artigo 12 da LPI – período de graça.
Informe no item 11.13 os documentos anexados, se houver.

**8. Declaração na forma do item 3.2 da Instrução Normativa PR nº 17/2013:**

☐ Declaro que os dados fornecidos no presente formulário são idênticos ao da certidão de depósito ou documento equivalente do pedido cuja prioridade está sendo reivindicada.

**9. Procurador (74):**

9.1 Nome: Jose Carlos Vaz e Dias
9.2 CNPJ/CPF: 283.288.681-72 9.3 API/OAB: OAB/RJ 147.683
9.4 Endereço Completo: R São Francisco Xavier 524, Sl 29F, Maracanã, Rio de Janeiro
9.5 CEP: 20550013
9.6 Telefone: 23340017 9.7 FAX:
9.8 E-mail: inovuerj@sr2.uerj.br

☐ continua em folha anexa

**10. Listagem de sequências biológicas.**
Informe nos itens 11.9 ao 11.12 os documentos anexados, se houver. ☐

INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL
Sistema de Gestão da Qualidade
Diretoria de Patentes

| DIRPA | Tipo de Documento: Formulário | DIRPA | Página: 3/3 |
|---|---|---|---|
| Título do Documento: Depósito de Pedido de Patente | | Código: FQ001 | Versão: 2 |
| | | Procedimento: DIRPA-PQ006 | |

**11. Documentos Anexados:**

(Assinale e indique também o número de folhas):
(Deverá ser indicado o número total de somente uma das vias de cada documento).

| | | Documentos Anexados | folhas |
|---|---|---|---|
| ☒ | 11.1 | Guia de Recolhimento da União (GRU). | 1 |
| ☒ | 11.2 | Procuração. | 1 |
| ☐ | 11.3 | Documentos de Prioridade. | |
| ☐ | 11.4 | Documento de contrato de trabalho. | |
| ☒ | 11.5 | Relatório descritivo. | 6 |
| ☒ | 11.6 | Reivindicações. | 1 |
| ☐ | 11.7 | Desenho(s) (se houver). Sugestão de figura a ser publicada com o resumo: nº, ______ por melhor representar a invenção (sujeito à avaliação do INPI). | |
| ☒ | 11.8 | Resumo. | 1 |
| ☐ | 11.9 | Listagem de sequências em arquivo eletrônico: ____ nº de CDs ou DVDs (original e cópia). | |
| ☐ | 11.10 | Código de controle alfanumérico no formato de código de barras referente às listagem de sequências. | |
| ☐ | 11.11 | Listagem de sequências em formato impresso. | |
| ☐ | 11.12 | Declaração relativa à Listagem de sequências. | |
| ☒ | 11.13 | Outros (especificar) Fotos impressas publicação no diário oficial; Estatuto documentos de Reitor | 43 |

**12. Total de folhas anexadas:** fls. 53

**13. Declaro, sob as penas da Lei que todas as informações acima prestadas são completas e verdadeiras.**

Rio, 5/12/2013
Local e Data

Assinatura e Carimbo
Prof. Dr. José Carlos Vaz e Dias
Coord. do Escritório de P.I.
InovUerj/SR-2/UERJ
Matr. 34523-1

CÓPIA

INPI
020130093977
18/12/2013 16:24 NPRJ
BR 30 2013 006612 6

Protocolo (22)

Nº DI (21)

## DEPÓSITO DE PEDIDO DE REGISTRO DE DESENHO INDUSTRIAL

**Ao Instituto Nacional da Propriedade Industrial**,
O requerente solicita a concessão do registro de desenho industrial nas condições abaixo indicadas:

**1. Depositante**
1.1 Nome (71): UNIVERSIDADE DO ESTADO DO RIO DE JANEIRO
1.2 Nacionalidade: Brasileira 1.3 Qualificação:
1.4 CPF/CNPJ (se houver): 33.540.014/0001-57
1.5 Endereço: Rua São Francisco Xavier, 524 – Sala T 29 - Bl F Bairro: Maracanã
Cidade: Rio de Janeiro Estado: RJ CEP: 20.550-013 País: Brasil
1.6 Telefone: ( 21) 2334-0017 2334-0018
Fax: ( )
E-mail: inovuerj@sr2.uerj.br

**continua em folha anexa**

**2. Título do Registro**
2.1 Título: Configuração Ornamental aplicada a instrumento para Gluteoplastia

2.2 Pedido Dividido: DI:

**continua em folha anexa**

**3. Campo de Aplicação**
Instrumentos cirúrgicos

**continua em folha anexa**

**4. Prioridade**
4.1 O depositante reivindica prioridades de Depósito? sim não

| País ou Organização de Origem | Número do Depósito **(transcrever exatamente o n°que consta na prioridade)** | Data do Depósito |
|---|---|---|
| | | |
| | | |

**continua em folha anexa**

**5. Sigilo do Pedido**
5.1 Requer sigilo do pedido na forma do §1º do art. 106 da LPI ? sim não

**6. Autor (es)**
6.1 Requer a não divulgação de seu(s) nome(s) de acordo com o art. 6° § 4° da LPI?
(vide procedimento conforme item 1.1 do Ato Normativo n°161/2002) sim não

6.2 Nome (71): Fernando Serra Guimarães
6.3 Nacionalidade: brasileiro 6.4 Qualificação: Professor pesquisador da UERJ
6.5 CPF/CNPJ (se houver): 07175694709
6.6 Endereço: Rua de Paranhos Antunes, nº. 100, ap 106, Bloco 1. Bairro: Barra da Tijuca
Cidade: Rio de Janeiro Estado: Rio de Janeiro. CEP: 22620-300 - País: Brasil
6.7 Telefone: ( 21) 91769718
Fax: ( )
E-mail: fserrag@gmail.com

**continua em folha anexa**

**Formulário nº 2.01** – Depósito de Pedido de Registro de Desenho Industrial (folha 1 de 2)

7. **Declaração na forma do item 3.2 do ato Normativo nº161/02 (relativa à tradução simples da prioridade)**

**continua em folha anexa**

8. **Declaração de divulgação anterior não prejudicial (art. 96 § 3º da LPI – Periodo de Graça)**

**continua em folha anexa**

9. **Procurador**
9.1 Nome: Jose Carlos Vaz e Dias
9.2 API ou OAB: OAB/RJ 147.683
9.3 CPF/CNPJ: 283.288.681-72
9.4 Endereço: Rua São Francisco Xavier, 524 - Sala T 29 - Bl F, Bairro: - Maracanã
Cidade: Rio de Janeiro Estado: Rio de Janeiro Cep: -20.550-013
9.5 Telefone: ( 21) 23340017
Fax: ( )
E-mail: inovuerj@sr2.uerj.br ou mbruno@ime.uerj.br

10. **Documentos anexados (assinalar e indicar o número de folhas correspondente a uma via do documento)**

| Apresenta: | | Nº folhas |
|---|---|---|
| x | Guia de Recolhimento pessoa física x pessoa jurídica | 1 |
| x | Procuração | 1 |
| | Documento de Prioridade | |
| x | Relatório Descritivo | 1 |
| x | Reivindicação | 1 |
| x | Desenhos ou Fotografias em preto e branco | 4 |
| | Desenhos ou Fotografias em cores | |
| x | Outros (especificar): Estatuto; doc. iniciais; publicação DO | 39 |
| | **Total de folhas anexadas** | 48 |

11. **Declaro, sob penas da lei, que todas as informações acima prestadas são completas e verdadeiras.**

Rio, 5 de dezembro 2013
Local e Data

Assinatura e Carimbo
(procurador ou depositante)
Prof. Dr. José Carlos Vaz e Dias
Coord. do Escritório de P.I.
InovUerj/SR-2/UERJ
Matr. 34523-1

**ANEXO B-** Parecer do Comitê de Ética em Pesquisa

INTO
INSTITUTO NACIONAL DE TRAUMATOLOGIA E ORTOPEDIA

MINISTÉRIO DA SAÚDE
SECRETARIA DE ATENÇÃO À SAÚDE
INSTITUTO NACIONAL DE TRAUMATOLOGIA E ORTOPEDIA

COMITÊ DE ÉTICA EM PESQUISA

Certificamos que o projeto intitulado **Estudo do comportamento muscular após gluteoplástia** protocolo **nº 0011.0.305.305-10**, desenvolvido sob a responsabilidade de **Fernando Serra**, está de acordo com os princípios éticos estabelecidos pela Resolução 196/96 do Conselho Nacional de Saúde, tendo sido APROVADO em 28/04/2010 na reunião do Comitê de Ética em Pesquisa do Instituto Nacional de Traumatologia e Ortopedia (INTO).

O Pesquisador está autorizado a dar início à pesquisa em pauta, devendo atender às seguintes exigências:

- Encaminhar a este CEP, **relatório descritivo de seu andamento ao final de cada semestre;**
- **Ao término da pesquisa, apresentar cópia do trabalho concluído**, conforme metodologia exigida pela instituição, **impressa e em mídia**.

Rio de Janeiro, 03 de maio de 2010

*Dr. Sérgio Eduardo Vianna*

**Coordenador do**
**Comitê de Ética em Pesquisa do INTO**