Ana Flávia de Oliveira Barros

Reconstrução facial forense tridimensional computadorizada a partir de um crânio

Brasília
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Trabalho de Conclusão de Curso apresentado ao Departamento de Odontologia da Faculdade de Ciências da Saúde da Universidade de Brasília, como requisito parcial para a conclusão do curso de Graduação em Odontologia.

Orientador: Prof. Dr. Malthus Fonseca Galvão

Brasília
2019

Às famílias dos falecidos não identificados

AGRADECIMENTOS

Agradeço primeiramente à Deus.

À minha família que sempre foi a minha base e meu exemplo.

Aos meus professores por todo conhecimento transmitido, em especial, ao meu querido orientador e incentivador Prof. Malthus, que me ensinou a olhar por aqueles que muitas vezes não são vistos e entender o verdadeiro sentido de justiça. Ao senhor, professor, o meu eterno carinho e gratidão.

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Por fim, aos meus amigos que fizeram destes cinco anos os mais proveitosos.

EPÍGRAFE

"*Nem sempre terás o que desejas, mas enquanto estiveres ajudando aos outros encontrarás os recursos de que precisas*".

Chico Xavier

RESUMO

BARROS, Ana Flávia de Oliveira. Reconstrução facial forense tridimensional computadorizada a partir de um crânio. 2019. Trabalho de Conclusão de Curso (Graduação em Odontologia) – Departamento de Odontologia da Faculdade de Ciências da Saúde da Universidade de Brasília.

A Reconstrução Facial Forense (RFF) tridimensional objetiva auxiliar a identificação humana quando os métodos tradicionais são inexequíveis por falta de indicação de pessoa desaparecida a ser comparada com os restos mortais encontrados. A técnica computadorizada, visa reconstruir a face a partir de um crânio, com base em estudos anatômicos estatísticos, para recriar, de forma aproximada, a aparência *ante-mortem* do indivíduo, a fim de que o resultado possa ser divulgado e a vítima reconhecida e, então, a metodologia científica aplicada para a identificação. O objetivo deste estudo é descrever a técnica da RFF tridimensional computadorizada a partir de um crânio do acervo do Laboratório de Odontologia Forense e Medicina Legal da Universidade de Brasília, por meio de programas gratuitos. Ao fim do estudo, observou-se que as tecnologias empregadas são acessíveis e podem ser utilizadas no auxílio à identificação.

ABSTRACT

BARROS, Ana Flávia de Oliveira. Computerized three-dimensional forensic facial reconstruction from a skull. 2019. Undergraduate Course Final Monograph (Undergraduate Course in Dentistry) – Department of Dentistry, School of Health Sciences, University of Brasília.

Three-dimensional Forensic Facial Reconstruction (FFR) aims to assist human identification when traditional methods are impracticable due to lack of indication of the missing person to be compared with the remains found. The technique, manual or computerized, has the goal to reconstruct the face from a skull, based on statistical anatomical studies, to roughly re-create the *ante-mortem* appearance of the individual, so that it can be recognized and then, the applied scientific methodology for identification. The objective of this study is to describe the computed three-dimensional RFF technique using a skull from the collection of the Laboratory of Forensic Dentistry and Legal Medicine of the University of Brasília, through free programs. At the end of the study, it was observed that the technologies employed are accessible and can be used to aid identification.

SUMÁRIO

ARTIGO CIENTÍFICO

Este trabalho de Conclusão de Curso é baseado nas normas de publicação da revista Forensic Science International.

FOLHA DE TÍTULO

Reconstrução facial forense tridimensional computadorizada a partir de um crânio

Computerized three-dimensional forensic facial reconstruction from a skull

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RESUMO

Reconstrução facial forense tridimensional computadorizada a partir de um crânio

Resumo

A Reconstrução Facial Forense (RFF) tridimensional objetiva auxiliar a identificação humana quando os métodos tradicionais são inexequíveis por falta de indicação de pessoa desaparecida a ser comparada com os restos mortais encontrados. A técnica computadorizada, visa reconstruir a face a partir de um crânio, com base em estudos anatômicos estatísticos, para recriar, de forma aproximada, a aparência *ante-mortem* do indivíduo, a fim de que o resultado possa ser divulgado e a vítima reconhecida e, então, a metodologia científica aplicada para a identificação. O objetivo deste estudo é descrever a técnica da RFF tridimensional computadorizada a partir de um crânio do acervo do Laboratório de Odontologia Forense e Medicina Legal da Universidade de Brasília, por meio de programas gratuitos. Ao fim do estudo, observou-se que as tecnologias empregadas são acessíveis e podem ser utilizadas no auxílio à identificação.

Palavras-chave

Identificação Humana; Antropologia Forense; Odontologia Forense; Tecnologia 3D; Reconstrução Facial Forense.

Relevância Científica e Social

A grande quantidade de pessoas falecidas sem identificação no Brasil é um grande desafio científico que demanda uma aplicação cada vez crescente das tecnologias científicas disponíveis.

ABSTRACT

Computerized three-dimensional forensic facial reconstruction from a skull

Abstract

Three-dimensional Forensic Facial Reconstruction (FFR) aims to assist human identification when traditional methods are impracticable due to lack of indication of the missing person to be compared with the remains found. The technique, manual or computerized, has the goal to reconstruct the face from a skull, based on statistical anatomical studies, to roughly re-create the *ante-mortem* appearance of the individual, so that it can be recognized and then, the applied scientific methodology for identification. The objective of this study is to describe the computed three-dimensional RFF technique using a skull from the collection of the Laboratory of Forensic Dentistry and Legal Medicine of the University of Brasília, through free programs. At the end of the study, it was observed that the technologies employed are accessible and can be used to aid identification.

Keywords

Human Identification; Forensic Anthropology; Forensic Dentistry; 3D technology; Forensic Facial Reconstruction.

INTRODUÇÃO

A aplicação dos métodos de identificação humana é uma necessidade no contexto do trabalho de um Instituto de Medicina Legal - IML. O trabalho pericial para a determinação da identidade de um cadáver é um desafio, especialmente quando este está parcialmente destruído como nos casos de corpos desmembrados, desfigurados, esqueletizados, carbonizados, vítimas de desastre de massa, putrefeitos, entre outros. Quando esses corpos são encontrados já em avançado estado de decomposição e não temos uma indicação da identidade da pessoa desaparecida correspondente, não teremos informações *intra-vitae* para comparação, o que impossibilita a aplicação dos protocolos preconizados pelo Guia DVI (*Disaster Victims Identification*) da Interpol, necropapiloscopia, odontologia forense e genética [1]. Nestes casos, a reconstrução facial forense (RFF) é uma opção, desde que, naturalmente, presente o crânio. Por ser considerado um método auxiliar à identificação humana [2], a RFF é uma técnica lastreada em padrões científicos e artísticos que objetiva reconstruir a face a partir do crânio, para recriar a aparência *ante-mortem* aproximada do indivíduo, a fim de que alguém possa reconhecer a fisionomia e, posteriormente, seja realizada a identificação científica do falecido [3]. É importante destacar a diferença entre identificação e reconhecimento.

A identificação parte do princípio da busca por elementos que permitam a individualização de um indivíduo, ao comparar características que sejam coincidentes entre os dados *ante-mortem* e *pos-mortem* [4]. Em tese, existem cinco parâmetros para que a identificação humana seja aplicável: unicidade, imutabilidade, perenidade, critérios esses considerados técnicos e os práticos, praticabilidade e classificabilidade. Estes critérios técnicos não se aplicam de forma absoluta na antropologia forense como na necropapiloscopia ou genética, posto que a unicidade deveria ser entendida como raridade, ao passo que a imutabilidade deve ser percebida enquanto uma mutabilidade unidirecional tempo dependente [5]. O ato do reconhecimento é muito subjetivo, pois depende da lembrança da aparência do indivíduo em vida e de outros fatores emocionais e, portanto, não confiável [4]. A antropologia forense, a partir da análise do sexo,

idade, estatura, ancestralidade e características individuais permite muitas vezes a identificação humana e, por consequência, levar a verdade à investigação e à justiça [6]. Não é um trabalho isolado, depende da atuação de uma equipe multidisciplinar [7].
A RFF tridimensional pode ser feita por duas técnicas: a manual, na qual se reconstrói a face pela aplicação de argila ou outros materiais sobre uma réplica do crânio e a computadorizada. Nesta técnica, objetivo do presente trabalho, o crânio é digitalizado por tomografia e fotogrametria e a sua reconstrução realizada pelo uso de programas livres, o que será demonstrado a partir de um crânio do acervo do Laboratório de Odontologia Forense e Medicina legal – LOFMEL da Universidade de Brasília - UnB.

MATERIAIS E MÉTODOS

Foi selecionado de modo aleatório um crânio do acervo do LOFMEL- UnB, denominado CC.01 (Figura 1). Uma folha centimetrada foi separada e colocada sobre a mesa. A obtenção das imagens foi realizada com a câmera de um celular *Samsung SM-G900M*®, com resolução ajustada para 5.312 x 2.988 pixels, e também por um tomógrafo computadorizado *SOMATOM Scape – SIMENS*® de 16 canais com reconstrução tridimensional, da Seção de Radiologia Forense do IML-DF[1] (Figura 2).
Para o processamento das imagens e efetiva reconstrução por modelagem tridimensional, foram utilizados os seguintes programas gratuitos: *MeshLab*®, *Blender*®, *InVesalius*®, *MakeHuman*®, *Recap 360*® e *FaceApp*® (Tabela 1).

[1] Autorização SEI CV 3177669 CRC 14370235 – Processo 23106.050759/2018-98

Figura 1 – Crânio CC.01. Acervo do LOFMEL - UnB

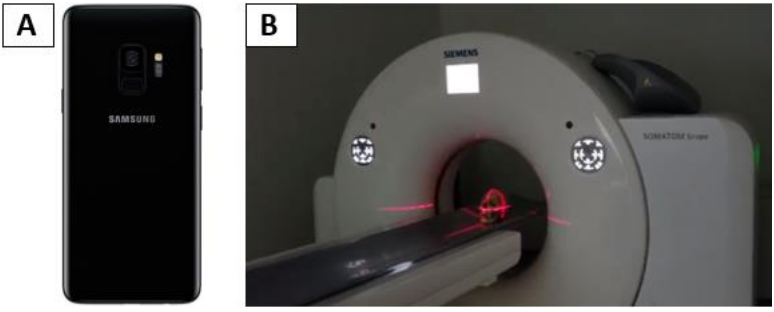

Figura 2 – A – Celular *Samsung SM-G900M*® . B - Tomógrafo *SOMATOM Scape – SIMENS*® do IML-DF

Tabela 1 – Descrição dos programas instalados no computador com seus respectivos custos

Programa	Descrição	Custo
 MeshLab®	Software de processamento de malha 3D	Gratuito
 Blender®	Software de computação gráfica 3D com recursos de modelagem e efeitos visuais	Gratuito
 InVesalius®	Software brasileiro que reconstrói tridimensionalmente as imagens DICOM e permite a geração de arquivos 3D	Gratuito
 MakeHuman®	Software que gera modelos humanoides em 3D capazes de serem editados	Gratuito
 Recap 360®	Permite captar a realidade a partir de fotos e construir automaticamente um modelo tridimensional	Gratuito
 FaceApp®	Aplicativo semelhante a um photoshop capaz de editar imagens e inserir diferentes texturas	Gratuito

1) ANÁLISE ANTROPOLÓGICA DO CRÂNIO

Uma análise antropológica revela diferenças cranianas relativas ao sexo, idade e ancestralidade [8] (Figura 3).

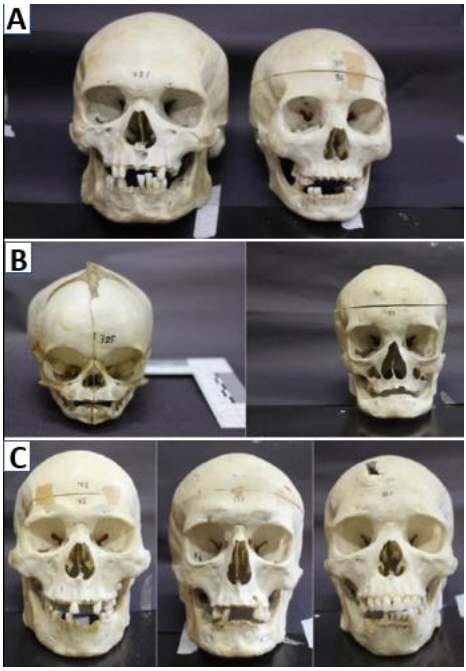

Figura 3 – A- Dimorfismo sexual. Masculino (esquerda) e feminino (direita). B- Variação de idade. Feto de sete meses (esquerda) e idoso (direita). C- Diferentes ancestralidades. Asiática (esquerda), européia (centro) e africana (direita). Fotos: Paulo Miamoto, coleção anatômica da Escola Paulista de Medicina (EPM)

Com base na análise antroposcópica do crânio CC.01, foi possível observar uma glabela bem proeminiente, apófise mastóide desenvolvida, arco supraciliar saliente, mandíbula arqueada, rebordo supra-orbitário relativamente rombo, características essas compatíveis com o sexo masculino. A erupção do terceiro molar superior esquerdo, as perdas ósseas alveolares maxilares, as ausências dentárias posteriores inferiores bilaterais com respectivos alvéolos remodelados, os desgastes das bordas incisais (Figura 4) e o apagamento quase total da sutura sagital e coronal (Figura 5) são indícios de se

tratar de um adulto não jovem [9]. Para aplicação da técnica de RFF, estimou-se a idade como entre quarenta e cinquenta anos. As ausências dentárias anteriores inferiores, com respectivos alvéolos com bordas agudas e persistência da lâmina alveolar cribiforme são indicativos de perda *post-mortem* [6]. A ancestralidade foi considerada como miscigenada em função da anatomia das órbitas, da mandíbula, entre outros.

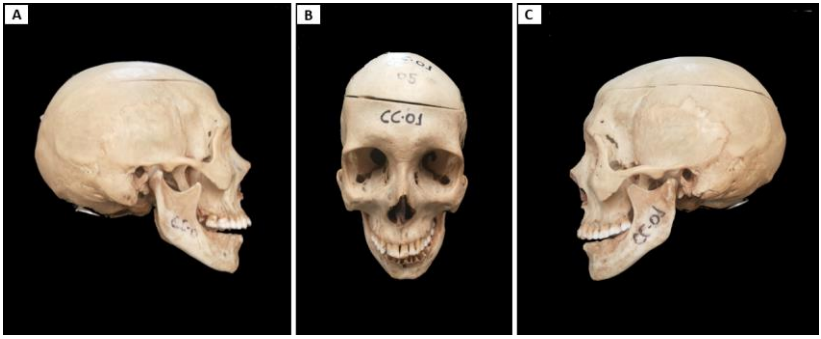

Figura 4 – Crânio CC.01. A- Vista lateral direita. B- Vista frontal. C- Vista lateral esquerda

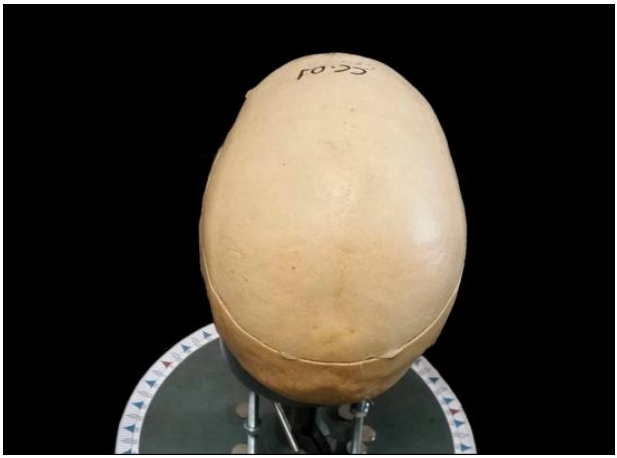

Figura 5 – Crânio CC.01. Vista superior do crânio. Tenuidade das suturas cranianas

2) DIGITALIZAÇÃO DO CRÂNIO

Para a aplicação da técnica da RFF, é necessário obter a representação digital tridimensional do crânio com a mandíbula em posição anatômica.

A digitalização craniana foi feita primeiramente por tomografia computadorizada (Figura 6) , a qual gera um arquivo do tipo *DICOM*. Este formato de arquivo não pode ser aberto pelo programa Blender® e, para contornar esta limitação, foi utilizado o programa *InVesalius*® (Figura 7) que o lê e permite que a imagem seja exportada no formato STL[2], que pode ser lido pelo Blender® [10]. Quando não se dispõe de equipamentos de imaginologia como um tomógrafo ou scanner, a fotogrametria pode ser empregada [11].

A fotogrametria consiste em várias tomadas fotográficas do objeto, no caso o crânio, em diferentes ângulos, com uma diferença aproximada de 12° entre uma e outra [11]. Foram realizadas 30 fotos para que o programa *Recap360*® pudesse gerar uma nuvem de pontos e criar uma malha 3D, sobre a qual se aplicou uma textura, obtendo-se o objeto de interesse em 3D (Figuras 8 e 9).

Figura 6 – Tomografia do crânio CC.01. Tomógrafo do IML-DF

[2] Stereolithography

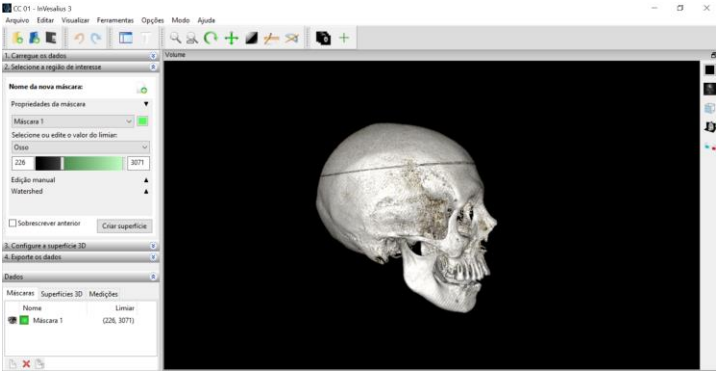

Figura 7 – Interface do programa *InVesalius*®. Imagem tomográfica do crânio CC.01. Vista lateral direita

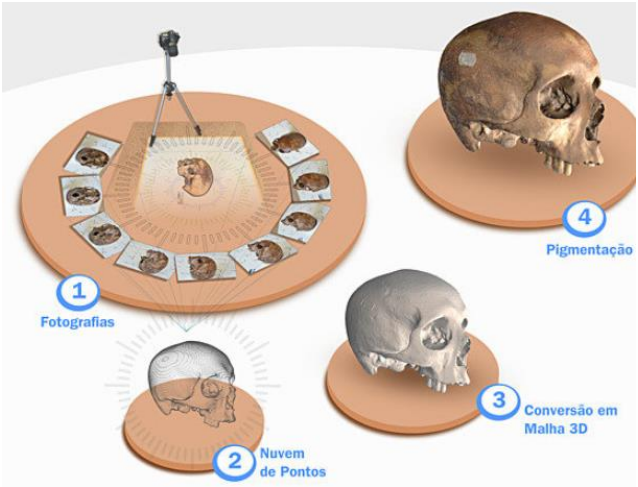

Figura 8 – Técnica da digitalização por fotogrametria. Foto: Moraes e Miamoto, 2017. Escaneamento 3D por fotogrametria e software livre aplicado à Reconstrução Facial Forense

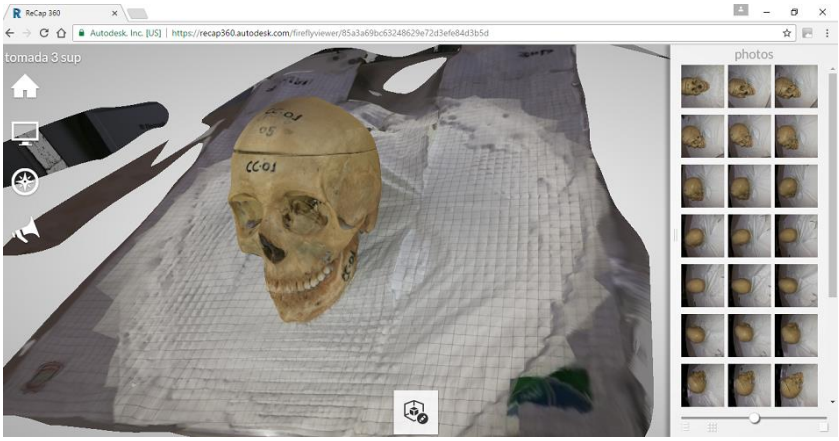

Figura 9 – Interface do programa online *Recap360*®. Crânio em 3D resultado da fotogrametria

3) PREPARO DO CRÂNIO

Quando a digitalização é feita pela fotogrametria, o arquivo em 3D deve ser importado ao programa *MeshLab*® e colocado em escala de 1:1 (Figura 10). Após isso, a cena em 3D ao redor do crânio deve ser excluída para que reste apenas o objeto de interesse e, assim, exportado no formato STL, para que possa ser lido pelo programa *Blender*® [10] (Figura 11).

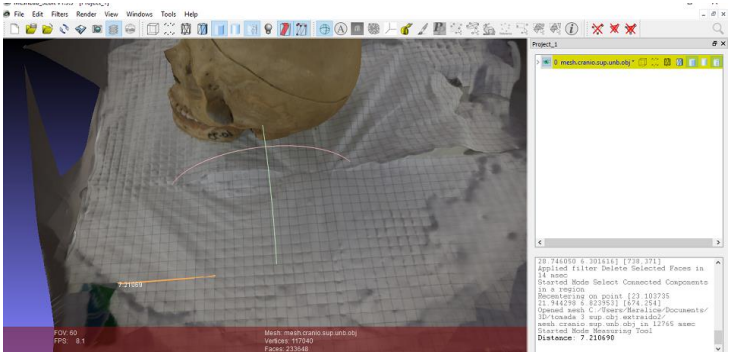

Figura 10 – Interface do programa *MeshLab*®. Conversão em escala 1:1

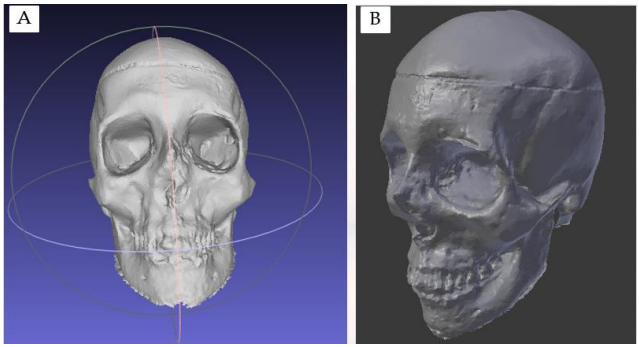

Figura 11 – A- Crânio após a remoção do cenário pelo *MeshLab*®. B- Crânio exportado em STL e aberto pelo programa *Blender*®

4) MARCADORES DE ESPESSURA DE TECIDO MOLE

As espessuras de tecidos moles a serem aplicadas na presente reconstrução foram obtidas a partir de estudos prévios realizados em cadáveres, levando-se em conta idade, sexo e ancestralidade [12] (Figura 12). Na literatura existem diversas tabelas, resultado de estudos estatísticos que estabeleceram uma média populacional entre homens, mulheres e crianças de diversas ancestralidades, considerando o nível nutricional normal [13]. Para esta RFF, foi utilizada uma tabela para brasileiros em função do gênero [12] (Tabela 2).

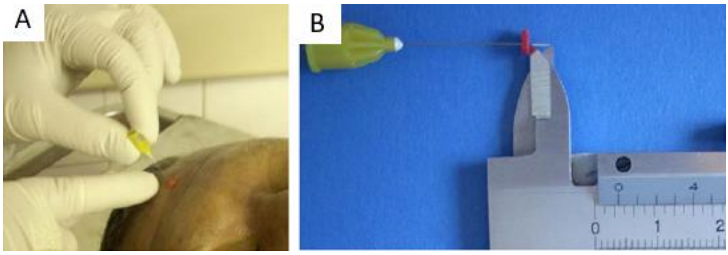

Figura 12 – A- Agulha localizada em ponto craniométrico em cadáver. B-Mensuração da profundidade com o paquímetro. Tedeschi,2008. Dissertação (Mestrado)

Tabela 2 – Espessura dos tecidos moles da face (mm) para uma amostra de brasileiros em relação ao sexo. Tedeschi – Oliveira *et al*. 2008)

	Médias	
Localização	**Masculino (n=26)**	**Feminino (n=14)**
Linha mediana		
Supraglabela	5,01	4,37
Glabela	5,58	4,66
Nasion	5,90	5,09
Rinio	5,21	4,29
Philtrum Médio	10,60	7,73
Supradentale	9,10	8,74
Infradentale	10,62	9,42
Supramentale	11,00	9,16
Eminência Mentoniana	10,64	9,40
Menton	10,40	8,78
Bi Laterais		
Eminência Frontal	4,95	3,98
SupraOrbital	6,99	5,84
SubOrbital	6,56	6,01
Malar Inferior	11,25	10,00
Lateral da Órbita	9,10	9,23
Arco Zigomático	9,28	8,88
Supraglenóide	11,61	10,82
Gonion	12,71	10,97
SupraM2	16,41	14,43
Linha Oclusal	14,40	11,71
SubM2	14,60	11,32

5) INSERÇÃO DAS MEDIDAS DE ESPESSURA E TRAÇADOS DA FACE

No *Blender*®, o arquivo STL do crânio é aberto. O crânio deve ser, obrigatoriamente, posicionado no plano de Frankfurt. Para

cada ponto craniométrico, foi informada no programa a espessura de tecido mole, conforme a Tabela 2. Foram 10 pontos ímpares, ou seja, no plano sagital mediano e 11 pares bilaterais. Os globos oculares foram posicionados no alinhamento dos pontos craniométricos supra e infra-orbitários (Figura 13). O traçado do nariz foi realizado seguindo a técnica russa de Lebedinskaya [10], que segue o contorno da abertura piriforme em vista lateral (Figura 14). Em seguida, foi realizado o traçado da boca utilizando parâmetros como o centro dos olhos e o centro dos caninos superiores [10] (Figura 15).

Figura 13 – Interface do programa *Blender*®. Inserção dos marcadores de tecidos moles e globos oculares

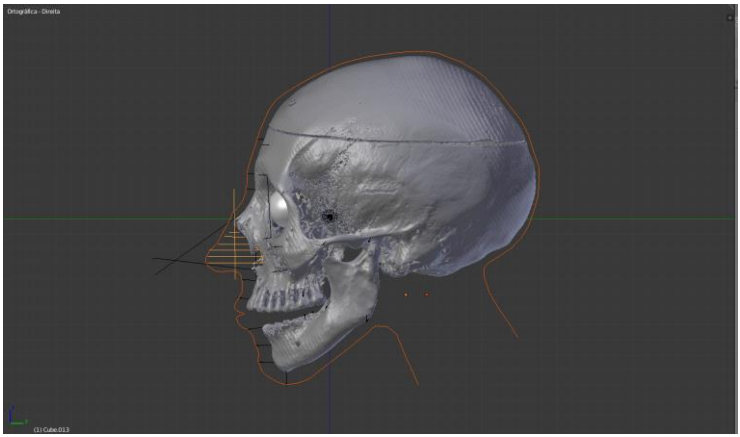

Figura 14 – Determinação do contorno da face e traçado do nariz

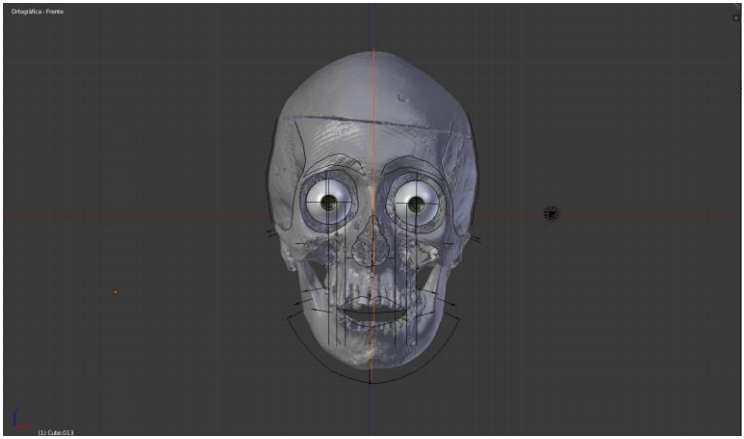

Figura 15 – Traçado da boca e demais contornos da face

6) INSERÇÃO DA PELE

Dados fornecidos pela antropologia forense pelo estudo do crânio CC.01, permitiu concluir tratar-se de um homem miscigenado de idade entre 40 e 50 anos. Esses dados são fornecidos ao programa *MakeHuman*® (Figura 16) ou ao Blender®, no *addon ManuelbastioniLAB*®. Desta forma, o arquivo STL do modelo foi aberto no programa Blender® [10].

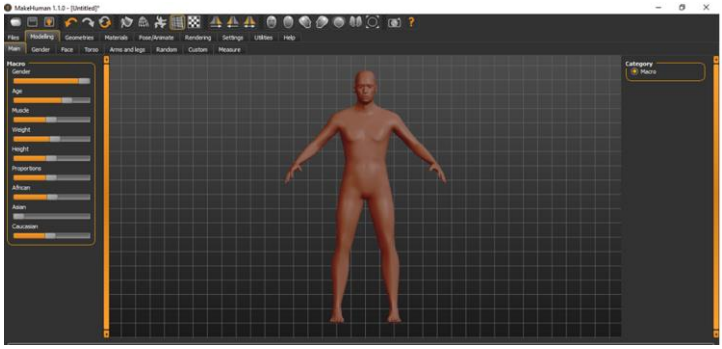

Figura 16 – Interface do programa *MakeHuman*® com os dados inseridos

No Blender®, esse modelo foi sobreposto em cima do crânio e as adaptações feitas de modo a seguir a linha guia principal e os marcadores de espessura de tecidos moles (Figura 17). Por fim, foi obtida a face já adaptada, em modo edição e modo objeto [10] (Figura 18).

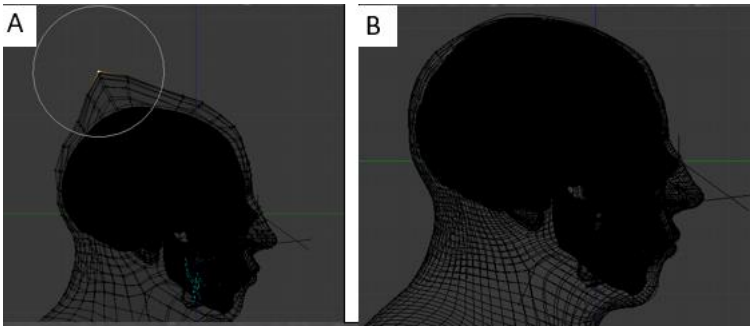

Figura 17 – Vista em modo de edição. A- Adequação do modelo à linha guia e aos marcadores de tecido mole. B- Adequação realizada

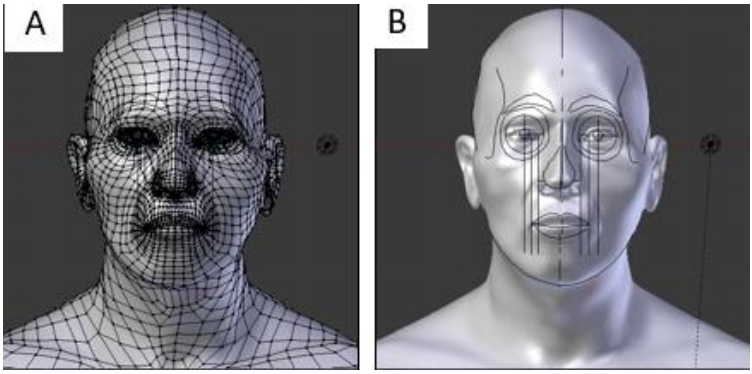

Figura 18 – A- Vista em modo de edição. B- Vista em modo objeto

RESULTADOS

O resultado foi submetido ao processo de renderização e uma tonalidade dada à pele (Figura 19). Porém, foi necessária a aplicação de uma textura humana sobre a pele, para que não se parecesse tanto com um “boneco” e tivesse mais sinais e traços próprios da idade. Para isso, um aplicativo de photoshop pode ser empregado, o *FaceApp*® (Figura 20). O resultado de uma RFF tridimensional, em tons de cinza, deve ser encaminhado às autoridades competentes para ser divulgada pela mídia na tentativa de levar a um reconhecimento da vítima por parte da população e, posterior, identificação científica [10] (Figura 21).

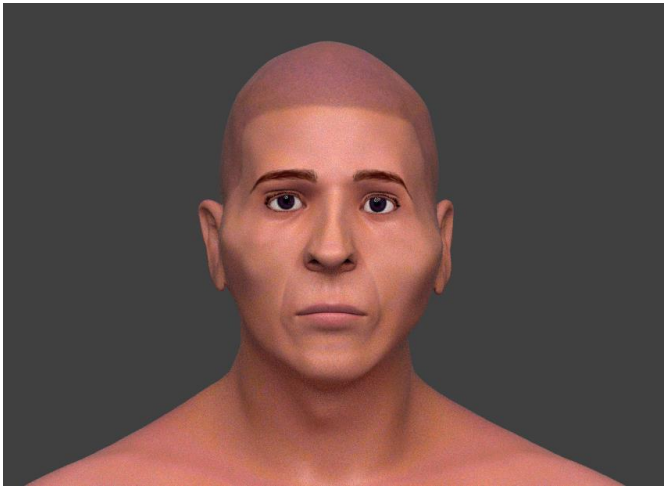

Figura 19 – Resultado após renderização

Figura 20 – Resultado após aplicação de textura humana no photoshop *FaceApp*®

Figura 21 – Resultado final da RFF tridimensional computadorizada. Divulgação nas mídias

DISCUSSÃO

Muito se questiona o fato de o resultado de qualquer RFF ser divulgado em tons de cinza. Em padrão de arte forense, quando não se tem uma informação acertada sobre determinada condição, nesse caso cor da pele, a cor deve ser reduzida a tons de cinza para que não ocorra indução ao erro no reconhecimento da vítima [7], assim como ocorre com os cabelos. Fernandes *et al.* [14] demonstraram que o índice de reconhecimento se mostrou mais elevado na reconstrução sem o cabelo. O que não quer dizer que seja proibida a divulgação com o cabelo. É importante que se tenha um banco de dados que possa ilustrar as diversas formas de apresentação da reconstrução, pois não se sabe a verdadeira face da vítima, como por exemplo, com óculos, barba, bigode, entre outros (Figura 22).

Outro fato é a escolha da tabela de espessura de tecido mole. Entre diversas tabelas, Fernandes *et al.* [15] comparou as pequenas diferenças entre duas tabelas brasileiras e uma internacional para determinada reconstrução e verificou estatisticamente que as medidas diferentes nos mesmos pontos não influenciaram significativamente na fisionomia e reconhecimento após a reconstrução, o que se pôde perceber foi uma face mais magra do que a outra.

Entre os métodos de digitalização aqui aplicados, a fotogrametria se mostrou uma técnica mais barata, porém, mais trabalhosa em relação à tomografia, pois seu resultado precisa ser convertido em escala 1:1 e a cena deve ser limpa, deixando apenas o objeto de interesse. Segundo os mesmos autores, a técnica computadorizada se sobrepôs à manual, pois essa possui mais gastos com os materiais e é operador-dependente. Segundo Vanezis *et al*. [16], ao se comparar as duas técnicas, a computadorizada foi mais rápida e flexível, e afirmou que ambas ainda precisam de mais estudos em relação aos dados de espessura de tecidos moles e também de um grupo controle para comparação.

Sobre a estimativa da idade pelas suturas cranianas, essas se mostraram bem variáveis. A margem de erro, segundo Bonnet [17], é de 30%, o que pode levar a uma diferença de 10 anos para mais ou para menos. A melhor técnica para a constatação

da idade é o nível de mineralização dentária, melhor até que a da erupção [5].
É importante citar que, ao encontro de uma ossada, se faz necessário uma análise minuciosa do local e que elementos podem ser integrados à reconstrução, como a presença do cabelo, o que poderá direcionar o resultado final. Vale ressaltar que, para o correto emprego da técnica, uma equipe multiprofissional que tenha conhecimentos em antropologia forense, arte forense e computação 3D deve ser consultada [7].

Figura 22 – Diversas formas de apresentação dos resultados da RFF tridimensional computadorizada do crânio CC.01

CONCLUSÃO

Na descrição desta técnica, foi possível constatar que tecnologias como a fotogrametria e os programas livres são acessíveis e podem ser empregados em institutos que não tenham condições de arcar com o custo de outras tecnologias como o tomógrafo ou scanner.
Que mais tecnologias acessíveis possam ser cada vez mais empregadas e aprimoradas na RFF, e que políticas públicas possam ajudar as tantas famílias que sofrem a dor da não identificação de seus entes falecidos.

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