UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

MARCELO VINICIUS DE OLIVEIRA

ANÁLISE MORFOMÉTRICA MANDIBULAR POR MEIO DE TOMOGRAFIA VOLUMÉTRICA VISANDO A MELHOR FORMA DE FIXAÇÃO INTERNA DA OSTEOTOMIA SAGITAL DO RAMO MANDIBULAR

TESE DE DOUTORADO APRESENTADA A FACULDADE DE ODONTOLOGIA DE PIRACICABA DA UNICAMP PARA OBTENÇÃO DO TITULO DE DOUTOR EM CLÍNICA ODONTOLÓGICA, NA ÁREA DE CIRURGIA E TRAUMATOLOGIA BUCOMAXILOFACIAIS.

ORIENTADOR: PROF. DR. JOSÉ RICARDO DE ALBERGARIA BARBOSA

ESTE EXEMPLAR CORRESPONDE À VERSÃO FINAL DA TESE DEFENDIDA PELO ALUNO MARCELO VINICIUS DE OLIVEIRA, E ORIENTADA PELO PROF.DR. JOSÉ RICARDO DE ALBERGARIA BARBOSA

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RESUMO

A osteotomia sagital do ramo mandibular (OSRM) como descrito por Obwegeser e Dal-Pont é atualmente um procedimento comum e de sucesso na cirurgia oral e maxilo-facial no tratamento de certas discrepâncias mandibulares. Em cirurgia ortognática, entre muitas diferentes propostas de osteotomia para correções de deformidades dento-faciais na mandíbula, é evidente que a osteotomia sagital da mandíbula (OSRM) é a mais utilizada pelos cirurgiões buco-maxilo-faciais. Este fato, devido a várias razões, principalmente a estabilidade alcançada pelo contato osso grande entre os segmentos, sem a necessidade de enxerto ósseo, função mandibular precoce; estabilidade no tratamento em longo prazo e fixação fácil. Diferentes métodos para fixação interna foram utilizados para permitir a mobilização precoce e funções após a OSRM. A introdução dispositivos de fixação interna, como miniplacas e parafusos diminui substancialmente a duração do bloqueio maxilo-mandibular ou mesmo o elimina completamente. A espessura da cortical óssea mandibular tem demonstrado ser um dos muitos fatores que levam a falha de afrouxamento de parafuso e, conseqüentemente, o poder de fixação do parafuso. Mensurações da morfologia mandibular utilizando métodos convencionais têm sido relatadas na literatura. Até o momento, apenas um estudo foi publicado em que analisa a espessura do osso cortical no ramo mandibular relacionando-a com fixação interna na osteotomia sagital do ramo mandibular. O objetivo deste estudo foi quantificar a espessura do osso cortical do ramo mandibular para determinar as condições relacionadas com a osteotomia sagital do ramo e colocação de parafusos. A amostra foi composta por 44 pacientes de pacientes, com idades variando de 46 a 52 (idade média de 49 anos). Tomografias computadorizada *Cone-Beam* foram realizadas fazendo três cortes; na área de terceiro molar (seção A), posterior 5mm (seção B) e 5 milímetros posterior a este último (seção C). Foram realizadas as medidas das corticais em nível superior e inferior relacionada com o canal mandibular além das medições relacionadas com a largura total da mandíbula. Coeficiente de correlação intra classe com $p < 0,05$ foi usado.

O resultado mostrou que as corticais vestibular e lingual não apresentaram diferenças estatísticas e seu menor valor foi 1,5 milímetros para cada um. Corticais ósseas superior e inferior não apresentaram diferenças e a largura total da mandíbula foi entre 15,9 milímetros a 8,5 milímetros na região anterior, entre os 17,4 milímetros a 12,8 milímetros na área intermediária e 18mm de 8,8 milímetros na região posterior. A distância superiormente ao canal mandibular apresentou um desvio padrão mínimo com uma média de 8,5 milímetros na região anterior, 10,6 milímetros para a região intermediária e 12,5 milímetros na região posterior. Em conclusão, a espessura cortical do ramo mandibular é particularmente forte e oferece um bom ancoradouro para SSRO osteossíntese com parafusos de fixação independente do tipo de disposição.

Palavras Chave: osteotomia sagital; mandíbula; fixação interna estável

ABSTRACT

The sagittal split ramus osteotomy (SSRO) as described by Obwegeser and Dal-Pont is now a standard, common and successful procedure in oral and maxillofacial surgery for the treatment of certain mandibular discrepancies. In orthognathic surgery, among many different designs proposed osteotomy for correction of dental-facial deformities in the jaw, it is clear that the sagittal osteotomy of the mandibular (OSRM) is the most commonly used by surgeons maxillofacial. This fact due to several reasons, mainly the stability achieved by the large bone contact between the segments, without the need for bone grafts, early jaw function; stability in long-term treatment and easy fixation. Different methods for internal fixation have been used to allow early mobilization and functions after the common use of the SSRO. The introduction of modern devices for internal fixation such as miniplates or lag screws substantially shortens the duration of intermaxillary fixation (IMF) or even obviates it completely. Cortical bone thickness has been shown to be one of many factors affecting screw pullout strength and, consequently, the holding power of the screw. Measurement of mandibular ramus morphology using conventional methods has been reported in the literature[28], but surgeons have found that further investigation of the anatomical relationship is needed. To date, only one study have been published in which the thickness of cortical bone at the mandibular ramus relates to stable internal fixation of SSRO. The objective of this study was to quantify the cortical bone thickness of the mandibular ramus to determine conditions related to sagittal split ramus osteotomy and placement of screws. The patient sample comprised 44 patients, ages ranging from 46 to 52 (mean age, 49 years). The cone beam computed tomography were performed and realized three cuts in third molar area (section A), 5mm posterior (section B) and 5mm posterior to the latter (section C). Was executed measurement in cortical areas of superior and inferior level related to mandibular canal and measurement related to total width of mandible. Intra class Correlation Coefficient with $p<0.05$ was used.

The result showed that buccal and lingual cortical zone was not present statistical differences and his minor value was 1.5mm for each one. Superior and inferior cortical bone was not present differences and the total width of mandible was between 15.9mm to 8.5mm in the anterior area, between 17.4mm to 12.8mm in the meddle area and 18mm to 8.8mm in the posterior area. The distance superiorly to mandible canal presented a minimal standard deviation with a mean of 8.5mm in the anterior region, 10.6mm for meddle region and 12.5mm in the posterior region. In conclusion, the cortical thickness of the mandibular ramus is particularly strong and offers a good anchorage for SSRO using osteosynthesis screws independently of disposition fixation type.

Key-words: sagittal osteotomy; mandible; stable internal fixation

SUMÁRIO

INTRODUÇÃO

Em cirurgia ortognática, dentre os mais diferentes desenhos de osteotomias propostas para correção das deformidades dento-faciais em mandíbula, é indubitável que a osteotomia sagital do ramo mandibular (OSRM) é a mais utilizada pelos cirurgiões buco-maxilo-faciais. Esse fato deve a diversos motivos, principalmente a estabilidade obtida pelo grande contato ósseo entre os segmentos, sem necessidade de enxertos ósseos e a estabilidade em longo prazo do tratamento (Turvey,1985).

A primeira cirurgia ortognática descrita na literatura foi realizada por Simon P. Hullihen, em 1847, nos Estados Unidos, em uma jovem que, queimada quando criança, apresentava uma contratura tecidual em face e pescoço causando uma significante deformidade mandibular (Hullihen, 1849). Este procedimento foi historicamente marcado como a primeira osteotomia mandibular, lembrando a atual técnica da osteotomia subapical anterior (Figura 1)(Aziz et al., 2004).

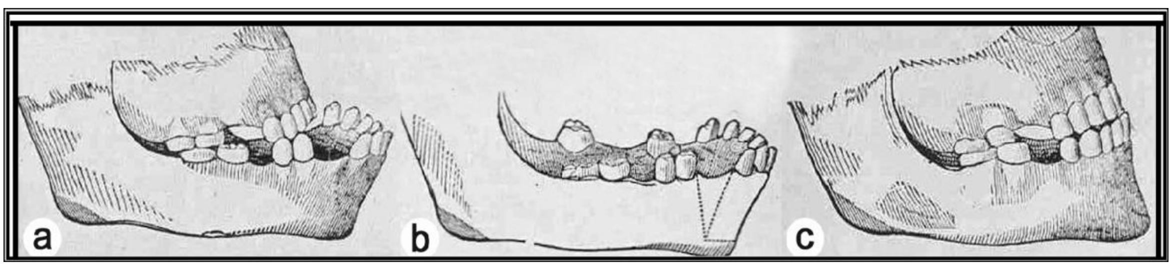

Figura 1 – Ilustrações da primeira cirurgia Ortognática realizada por Hullihen (1947). (a) Vista pré-operatória da mandibula; (b) Desenho da osteotomia; (c) Resultado pós-operatório.
Fonte: Aziz et al., 2004.

Somente no século XX foram obtidos os maiores desenvolvimentos técnicos para a realização da OSRM, iniciados pelo trabalho de Schuchardt, em 1942, na Alemanha. Este foi considerado a primeira osteotomia que apresentava um desenho de cortes no ramo mandibular com finalidade ortognática e uma configuração sagital, realizada por via intra-bucal.

A técnica original foi descrita por Trauner & Obwegeser (1957), consistindo de uma osteotomia através da cortical lateral do ramo da mandíbula, que vai da região distal do segundo molar até a borda posterior da mandíbula e uma corticotomia horizontal mais alta, através da face medial do ramo, acima da língula. Uma osteotomia sagital divide esses dois cortes, separando a mandíbula em dois segmentos, uma incluindo o côndilo e a outra os dentes (Figura 2).

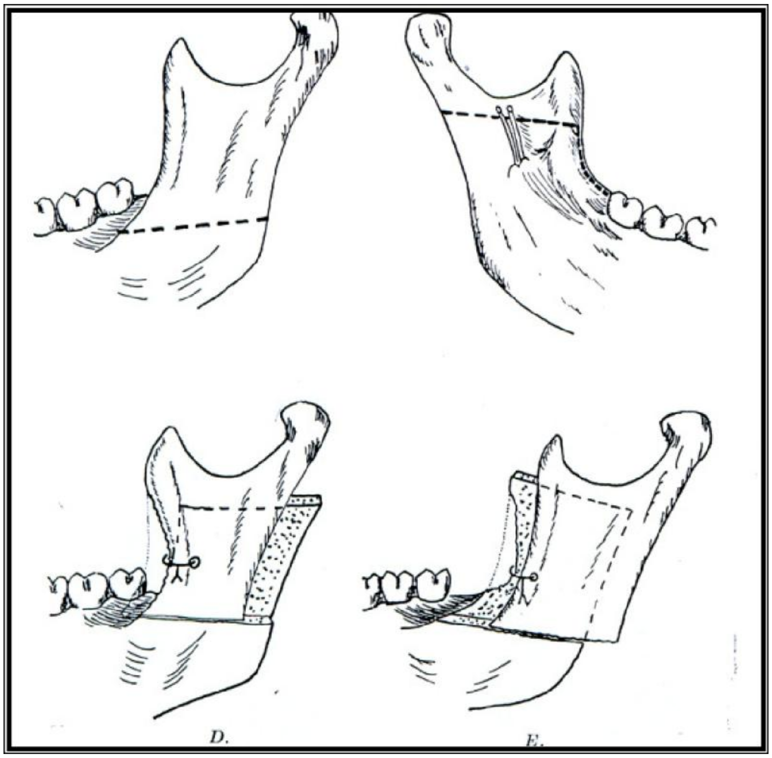

Figura 2 – Osteotomia Sagital Segundo Trauner & Obwegeser (1957)
Fonte: Trauner & Obwegeser (1957)

Epker (1977) sugeriu uma osteotomia sagital do ramo mandibular e certamente esse desenho foi amplamente utilizado por cirurgiões em todo mundo (Figura 3). Mas o grande avanço nessa modificação foi a previsibilidade dada a este procedimento minimizando complicações como sangramentos, danos ao nervo alveolar inferior (NAI), prevenção de exacerbamento do edema pós operatório, necrose avascular ou infecção do segmento proximal, ou seja, minimizando as recidivas e complicações dando a está técnica previsibilidade e confiabilidade. Visto que, anteriormente a osteotomia sagital bilateral do ramo mandibular possuia grande número de complicações como as anteriormente citadas.

No entanto, inúmeras alterações foram sugeridas para a técnica inicialmente proposta, objetivando a otimização de resultados e minimização de complicações. (Dal pont 1961; Hundsuck 1968; Gallo *et al*. 1976; Epker 1977; Bell & Schendel 1977; Niederdellmann & Shetty 1989; Wolford *et al.* 1987; Fun-Chee 1992; Wyatt 1997).

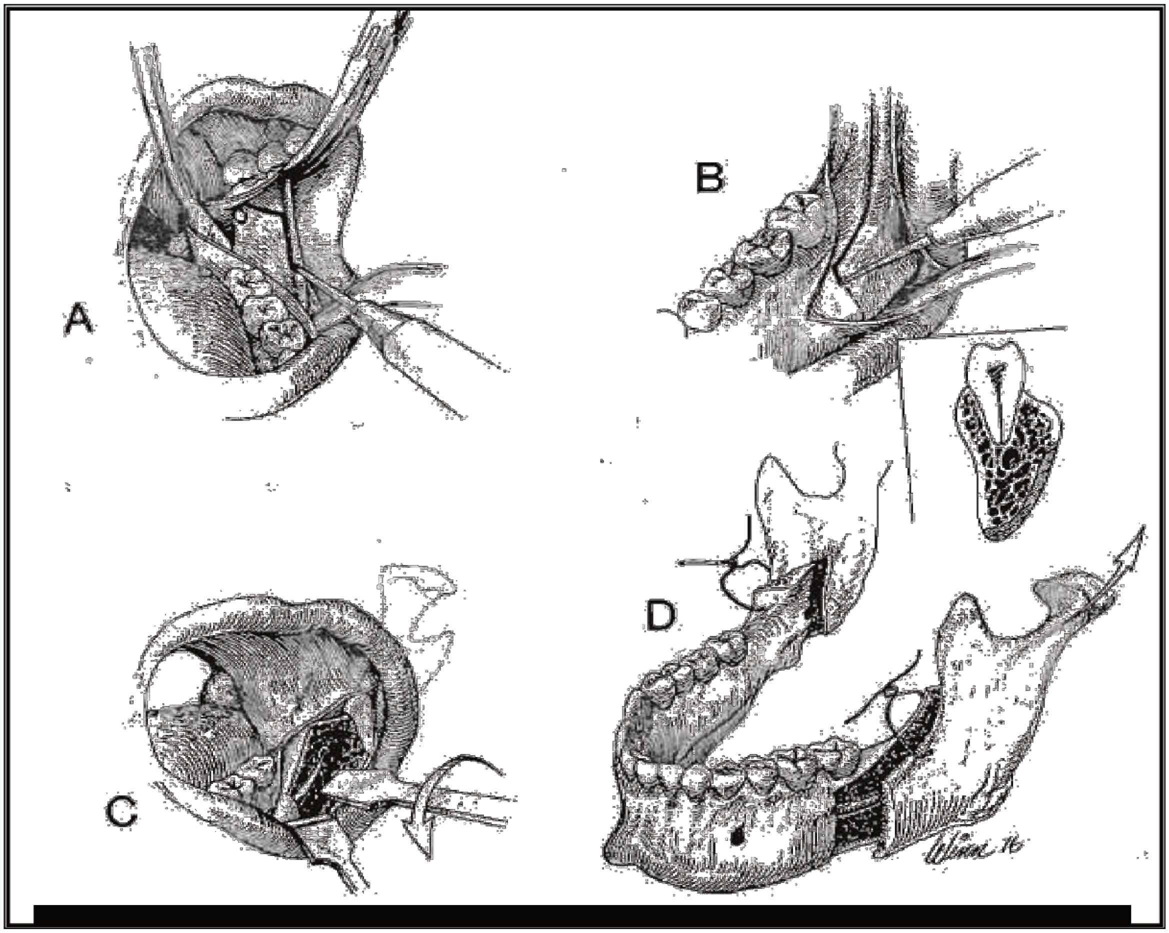

Figura 3 – Osteotomia Sagital do ramo mandibular utilizada pelo grupo I. Epker BN. Modifications in the sagital split of the mandible. J Oral Surg 35:362-365, 1977

O emprego da fixação interna rígida (FIR) à técnica da OSRM favoreceu a excelência nos seus resultados clínicos quanto à precocidade da função mandibular, adequada estabilização, controle dos segmentos e reparo ósseo por primeira intenção, além dos benefícios para o paciente, diminuindo ou eliminando o bloqueio maxilo-mandibular (Ochs, 2003). O reconhecimento destas vantagens expandiu rapidamente o emprego da FIR para a osteossíntese da OSRM, simultaneamente ao surgimento de diversas formas de fixação que otimizassem estes resultados (Schardt-Sacco, 2000).

Apesar da AO/ASIF (Arbeitsgemeinschaft für Osteosysntesefragen) divulgarem diretrizes para a utilização das técnicas de fixação, tem-se ainda grande diversidades de técnicas (Figura 4), cujas indicações ainda não foram completamente esclarecidas.

Apesar das inúmeras melhorias na técnica e ampla utilização da OSRM para correção das deformidades dentofaciais mandibulares esqueléticas, dentro os 30 anos, desde que o procedimento foi introduzido. uma série de complicações ainda ocorrem. Dentre estas, as principais complicações associadas à técnica da OSRM incluem fraturas incorretas (Mehra *et al*., 2001), hemorragias (Turvey, 1985), traumatismos neurossensoriais (Karabouta-Voulgaropoulou & Martis, 1984; Van Sickels *et al*., 2002), mau-posicionamento do segmento proximal, reabsorção condilar (Moore *et al*., 1991), disfunção temporomandibular (Nitzan & Dolwick, 1989; Flynn *et al*., 1990; Bouwman *et al*., 1994a; Onizawa *et al*., 1995), infecção e recidiva esquelética (Wolford *et al*., 1987; Bays, 1997).

Algumas destas complicações podem estar associadas direta ou indiretamente com o uso da FIR. Complicações tais quais sensibilidade ao metal, fratura dos materiais (miniplacas e parafusos), traumatismos dentais e nervosos (Hegtvedt & Zuniga, 1990; Schow *et al*., 1996), ferimentos em pele por má utilização do instrumental (Bouwman *et al*., 1995) e exposição de parafusos ou mini-placas (Jovanovic *et al*., 1996) estão estritamente associada ao emprego destes materiais (Frost 1999).

Atualmente, vários tipos de dispositivos de fixação estão sendo introduzidos no mercado e por isso trabalho científicos são importantes para certificação desses materiais, bem como configuração espacial de parafusos e placas para indicar a melhor disposição espacial levando a melhor resposta mecânica e física de cada situação. No entanto, para isto é necessário o detalhado conhecimento da morfologia do ramo mandibular focalizando os aspectos anatômicas importantes para a realização e fixação da OSRM que, desta forma irá direcionar conhecimentos necessários para o melhoramento da prática cirúrgica. Há relatos de estudos que analisaram diversos tipos de fixação da osteotomia sagital do ramo. As técnicas de fixação foi a variável introduzida nesse trabalho, o autores mostraram que a fixação por parafusos dispostos em L invertido foi estatisticamente superior aos outro tipos utilizados nesse trabalho (Brasileiro *et al*.,2009).

A efetividade da técnica dos parafusos posicionais necessita de uma adequada espessura da cortical óssea no segmento proximal, sendo a região mais superior da osteotomia o local ideal para inserção destes parafusos (Carter *et al*., 1991). Smith *et al*., em 1991, demonstraram em 49 mandíbulas de cadáveres humanos, que as corticais externa e interna da mandíbula foram significativamente mais espessas ao longo da linha oblíqua do que na borda inferior. Desta forma, os autores sugeriram possíveis vantagens adicionais na estabilidade de parafusos bicorticais se estes são colocados na borda superior.

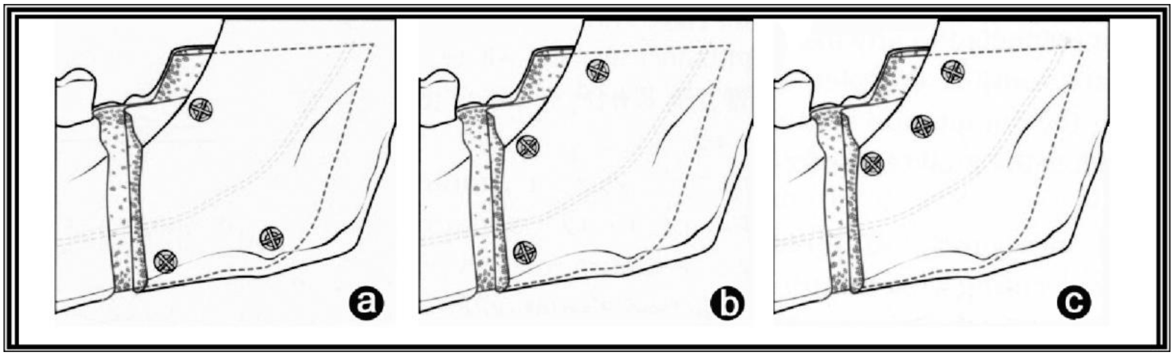

Figura 4 – Técnicas de inserção de parafusos bicorticais para a osteotomia sagital dos ramos mandibulares. (a) Configuração triangular. (b) Configuração em L-invertido. (c) Configuração linear.

Fonte: Assael,1998.

No entanto, há uma escassez na literatura de trabalhos científicos com foco na morfologia do ramo mandibular e OSRM que utilizem amostras de etnia brasileira. Desta forma, seria possível fazer comparações com outros estudos e possíveis discussões na realização da técnica e fixação em OSRM.

Além disto, outro ponto que merece destaque são as fraturas indesejadas envolvendo o segmento proximal, que são comuns, alcançando a incidência de até 8% (Turvey 1985). A literatura reconhece que ao realizar a OSRM, o risco de fratura indesejável aumenta de forma considerável com a presença de terceiros molares (Turvey,1985). Em particular uma variação anatômica predispõe a fratura indesejada no segmento proximal segundo Nishioka & Aragon (1989). A entrada do nervo alveolar inferior situada superiormente na parte interna do ramo ou presença de ramo mandibular delgado são as variações relacionadas pelo autor capaz de aumentar o risco de fraturas indesejáveis.

Um estudo anatômico da mandíbula realizado por Tom *et al* (1997) mostrou a significância da fusão das corticais interna e lateral da mandíbula no posicionamento do corte medial acima do forame mandibular na execução da técnica. A distância média acima da língula da mandíbula variou de 7,5 a 13,3mm, ou seja, a osteotomia 5mm acima da espinha deste acidente anatômico teria grande possibilidade de apresentar fraturas indesejadas coroborando com Nishioka & Aragorn (1989).

No entanto, Smith *et al.* (1991) com metodologia semelhante, realizaram um estudo anatômico em mandíbulas humanas e recomendaram que a osteotomia horizontal, por medial, fosse realizada ao nível do topo da língula ou ligeiramente acima dela devido a existência de um aumento na fusão das corticais óssea em um região mais superior que denota maior dificuldade de separação dos segmentos na OSRM aumentando a probabilidade de fratura indesejável e da incidência de danos ao nervo alveolar inferior.

Desta forma, esta tese apresenta 1 estudo morfométrico obtidos de crânios humanos em tomografias "*cone-beam*", subdividida em capítulos, objetivando avaliar a espessura e extensão das corticais ósseas no ramo mandibular que são de relevância para a realização e fixação da OSRM.

CAPITULO 1

Morphometrical Examinations of the Ramus Mandibular for the Indication Stable Internal Fixation to Sagittal Ramus Split Osteotomy: A Cone Beam Computer Tomography Study

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Keywords: sagittal split osteotomy; mandible; stable internal fixation

Purpose: The objective of this study was to analyse using cone beam computed tomography, quantifies the cortical bone thickness of the ramus mandibular to determine if there is an advantage to placement of bone screws in SRRO.

Material and Methods: The patient sample comprised 44 patients of both genders, who were select randomly with the ages ranging from 46 to 52 (mean age, 49 years). The cone beam computed tomography examinations were performed with the cuts used in this study were correspond to areas of clinical interest for stable intern fixation SSRO of the mandible using screws.

Results : Our results demonstrate that the cortical thickness (buccal and lingual) at the external oblique ridge no showed significantly thicker than those at the inferior border. (P<.005)

Conclusions: The cortical thickness the mandibular ramus is particularly strong and offers a good anchorage for SSRO using osteosynthesis screws independently of disposition fixation type.

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INTRODUCTION

The sagittal split ramus osteotomy (SSRO) is a common and successful technique used in oral and maxillofacial surgery for the treatment of certain mandibular discrepancies[23]. Actually is one of the most common surgical techniques to correct mandibular deformities including hypoplasia, hyperplasia, and asymmetries, because SSRO has numerous advantage show broad interface of bone associated with stability and healing, presence an intraoral approach without visible scar and presence of some different options for osseous fixation.

Sagittal split osteotomies of the mandible are often stabilized by plate and screw, bi cortical screw or mixtures of this technique[28,33]; this situation has been related to substantially shorten duration of IMF or even obviates it completely[34].In this direction, the stability is recognized how an important factor for healing and function and some studies show that the variation in arrangement of screws in mandibular ramus may influence the stability of SSRO.[17,18]

Cortical bone thickness has been shown to be one of factors affecting the screw pullout strength and, consequently, the holding power of the screw[32]. As cortical bone thickness increases, so does the screw pullout strength.

Measurement of mandibular ramus morphology using conventional methods has been reported in the literature[28], but has been indicated that further research of the anatomical relationship is needed; for other hand, can be observed differences between adult and young population in bone architecture, metabolism and response to surgical treatment, we must know that the adult population is increasingly his interest in orthognathic surgery, transforming to frequent surgical patient.

The aim of this research is to quantify the cortical bone thickness of mandible ramus in adult population and relate to screw fixation and SRRO with cone beam computed tomography.

MATERIALS AND METHODS / METHODOLOGY

Selection of sample and scan parameters

The patient sample comprised 44 patients of both genders, who were select randomly from patients at the Division of Oral and Maxillofacial Surgery and Division of Oral Radiology at Piracicaba Dental School, State University of Campinas with the ages ranging from 46 to 52 (mean age, 49 years). Patient with any systematic disease and bone disorders were excluded and only were accepted patient with complete dentition or with absence that not to exceed of one tooth in each maxilla or mandible arch. The CT examinations were performed with Cone Bean Computed Tomography (i-CATTM, 12-bit, Imaging Sciences International, Hatfield, PA) with the following scan parameters: scan time, 40s; 120 kV; 3-8 mA; field of view mode was 13cm; voxel- 0,25mm. The resultant slice image data was converted to 3D CT images in DICON format, reconstructed by XoranCat software (version 3.1.62) and imported to be evaluated in the iCATVision TM.2008 Version 1.8.1.10. The reconstructed image was 2mm (slice thickness) and cross-sectional CT images were obtained. The study protocol was approved by the Ethics in Human Research Committee of Piracicaba Dental School, State University of Campinas with number (138/1009).

Measurement procedure and selected point

For each cross sectional imaging, were evaluated the mandible cortical bone thickness (MCBT) of 88 hemi-mandibles at three specific locations perpendicular to the sagittal plane of the body. These sites were determined as vertical (coronal cuts) sections and identified with the letters A, B and C. The distance between each section was 5mm (Figure 1 and 2) and was divided the bone into equal thirds and the measurements were made at each superior and inferior section.

Section A –anterior area available for screw insertion: coronal cut on the anterior root of the third molar.

Section B –meddle area available for screw insertion: coronal cut 5mm posterior to section A.

Section C –posterior area available for screw insertion: coronal cut 5mm posterior to section B, on anterior border of the mandible ramus

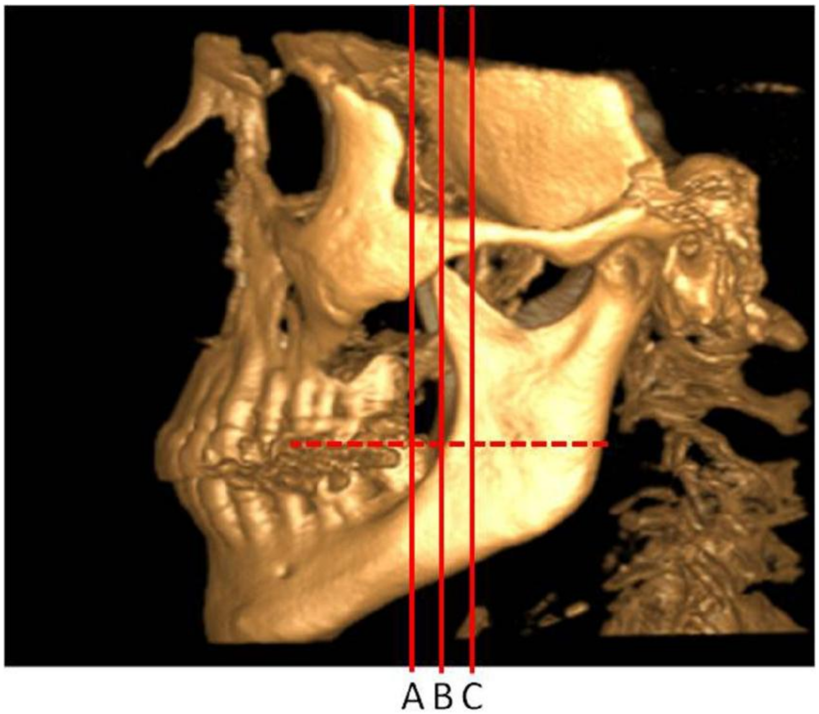

Figure 1. View 3D reconstruction of the points analyzed for measurements

The measurement was applied to buccal side and lingual side; for selection of superior and inferior landmark of measurement was considered:

- MCBT at 5mm above the inferior mandible border: the Inferior MCBT.
- MCBT at the superior border (external oblique ridge): the superior MCBT.

In this landmark, the measurement selected for this research were in relation to cortical thickness of buccal and lingual side, total mandible thickness, distance of mandible canal to superior point and distance to mandible canal to inferior point (mandible border).

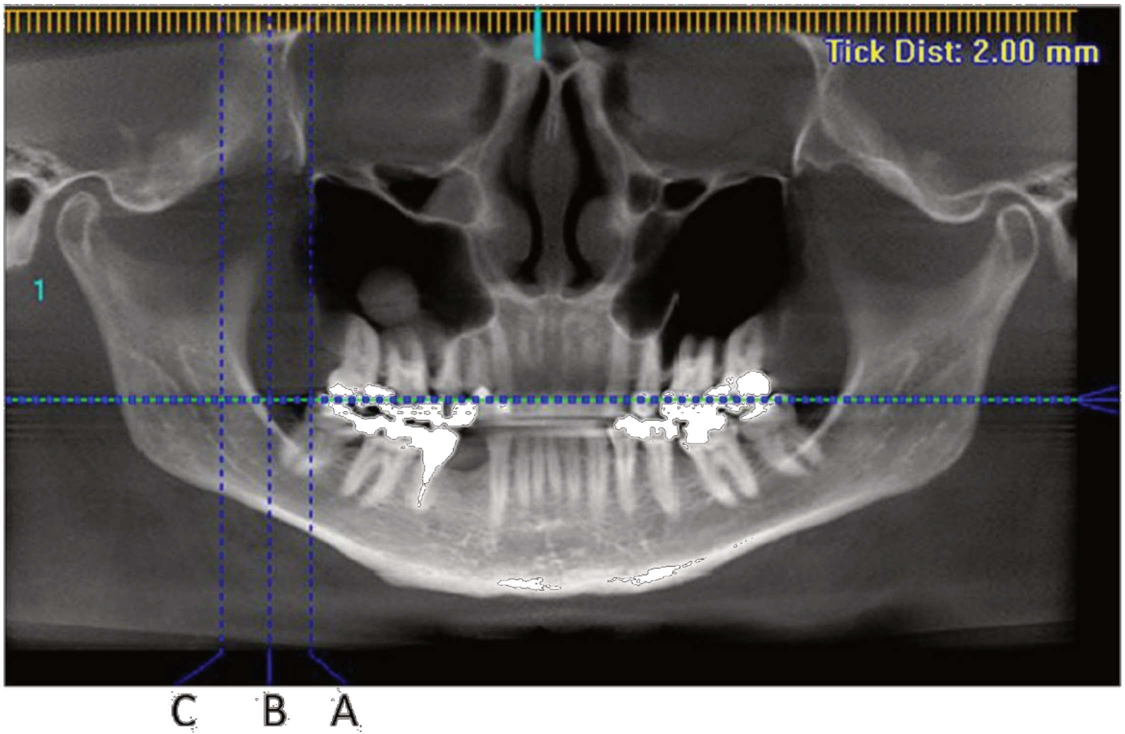

Figure 2. View panoramic and coronal slices of the points analyzed for measurements

One evaluator performed the measurements and reliability was assessed using replicate measurements. Intra-observer reliability was estimated based on two measurements performed at the right and left sides of the mandible with a 20-day interval to avoid dilution of error. The final mean values of each measurement resulted from the average of the 2 measurements.

Statistical analysis

Statistical analysis was performed by using SPSS software (Version 16.0, SPSS Chicago, Ill) and all data were expressed as mean and standard deviation. The Interclass Correlation Coefficient (ICC) with ANOVA was used for the intra-observer analyses concerning the quantitative indices. Differences between measures of the different subjects and sections (A,B and C) were compared according the mean values with *p* value less than 0.05.

RESULTS

Total thickness of mandible show that between the sections A, B or C is not present statistical differences (Table 1); the thickness in this section present minimal variations because of standard deviation was similar; for other hand, the superior area was present more thickness than inferior area and this situation was increasing when the measurement was more posterior, presenting differences of 2.8mm for section A, 5.1mm for section B and 5.9mm for section C; however, was not present statistical differences.

For buccal side (figure 3, 4 and 5), thickness of cortical bone was homogenous for the three measurements in the superior and inferior area with a mean close to 2.5mm; was not observed any statistical differences between them.

The lingual side was not present statistical differences (figure 3, 4 and 5) and show similar situation that the buccal side in order to minimum, maximum and mean cortical thickness over than 2mm.

Vertical measurement show distances to mandible canal and its relation for screw insertion; in the superior area (Table 2) was observed a mean of 8.5mm in section A, 10.6mm in section B and 12.5mm in section C. For inferior area (Table 3), this mean was 7.8mm in section A, 8.4mm in section B and 11.9mm in section C

Table 1. General data of MCBT at Buccal sections (mm; mean ± SD).

	MCBT (mm)				
Sections	**Inferior**	**Superior**	**Maximum**	**Minimum**	***P* value**
A	2.71 ± 0.37	2.50 ± 0.43	3.5	1.5	P<.005
B	2.56 ± 0.41	2.55 ± 0.62	3.75	1.5	P<.005
C	2.50 ± 0.50	2.25 ± 0.59	3.8	1.25	P<.005

Table 2. General data of MCBT at Lingual sections (mm; mean ± SD).

	MCBT (mm)				
Sections	**Inferior**	**Superior**	**Maximum**	**Minimum**	***P* value**
A	2.49 ± 0.52	2.29 ± 0.50	3.55	1.27	P<.005
B	2.47 ± 0.53	2.50 ± 0.60	3.50	1.46	P<.005
C	2.16 ± 0.47	2.26 ± 0.48	3.40	1.50	P<.005

Table 3. Vertical distance (mm) from a point just medial to the external oblique ridge to the superior edge of the mandibular canal.

Sections	Minimum	Maximum	Mean	SD
A	2.5	12.1	8.5	0.52
B	7.9	14.5	10.6	0.58
C	8.8	17.5	12.5	0.60

Table 4. Vertical distance (mm) from inferior edge of mandibular canal to inferior border of mandible

Sections	Minimum	Maximum	Mean	SD
A	6.51	12.9	7.8	0.50
B	6.52	13.8	8.4	0.50
C	7.22	16.7	11.9	0.54

Table 5. Thickness of the mandible (mm) at external oblique ridge and 5 mm above the inferior border of the mandible

Sections	Vertical Location	Min	Max	Mean	SD
A	EOR	8.5	15.9	12.6	0.56
	5 mm AIB	6.2	11.7	9.8	0.50
B	EOR	12.8	17.4	14.2	0.50
	5 mm AIB	5.3	13.3	9.1	0.51
C	EOR	8.8	18.0	12.9	0.52
	5 mm AIB	4.0	9.4	7.0	0.57

EOR = External Oblique Ridge; AIB = Above Inferior Border; P<.005

DISCUSSION

Methodology of measurement

For treatment of facial deformities it´s necessary accurate measurement of a variety of osseous and soft tissue landmarks. Historically, panoramic image has been used for evaluation of mandible morphology, but is recognized the problems related to this projection[1]; Previous studies suggest that projection geometry, focal plane shape, differential vertical and horizontal magnification, and operator error in patient positioning affect the utility of panoramic images to provide accurate measurements.[1-9] Although conventional computed tomography (CT) imaging provides higher accuracy with no significant difference between measurement of actual landmarks or CT images[10-11], this projection present relatively high x-ray dose and major economic cost. The introduction of low-dose, low-cost cone beam CT (CBCT) for oral and maxillofacial imaging holds the promise of overcoming these obstacles while providing more accurate craniometrical and diagnostic information than conventional radiographic techniques.[12]

Studies showed that both two-dimensional and three-dimensional techniques can be used for measurement of mandibular anatomy. However, an advantage of cone beam computed tomography measurement is not present a significantly influence by variation of skull orientation during image acquisition.[12]

Sagittal split ramus osteotomy considerations

Sagittal split ramus osteotomy (SSRO) is the most common surgical technique in mandible surgery. By definition, SSRO is superior to alveolar inferior nerve (AIN) and the osteotomy should be performed at the cortical level; when starting the osteotomy in the more posterior region, it is suggested not deeper than 8-10 mm into the manbible[18]. Based in the result of this research, for a safe osteotomy, the saw could be submerged a minimum of 8mm in section B and C and a minimum of 2,5mm in section A, to permit adequately weakening of mandible with total security for no lesion of AIN (in the saw cut).

Our results are in agreement with Smith *et al*. [28] with a mean vertical distance from the inferior border to the inferior aspect of the canal of 7.8 mm in the second molar area and 8.4 mm in the third molar area (Table 2). The minimum value in section A was 6.51 mm. For completed vertical osteotomy in the anterior area is necessary a minimum distance of 9.1mm with a mean of 16.3mm.

Osteosynthesis considerations

The osteosynthesis was a revolution in maxillofacial surgery when Spiessl, in 1974, recommended two screws placed at the external oblique ridge and one screw placed near the inferior border for cases of SSRO[22]. Since, several biomechanical studies have appeared in the scientific literature that compared different forms of stable internal fixation[21,23].

The biomechanical functions of rigid fixation systems, clinically, depend on the interaction between all three components, which are plate, screws and bone. A bone–plate–screw system requires precise adaptation of the plate to the underlying bone[27]. Without that intimate contact, the tightening of the screws could be mobilized the bone segment towards the plate and result in alterations in the position of the segments and the occlusal relationship. Other options of fixation are related to positional bicortical screw that permit stability and function without plate, decreasing the risk associated to no adaptation of plate.

Some published studies have reported the reversed “L” arrangement to be the most resistant bicortical fixation[13-17]; however, no register of statistical significance is available when compared it with the linear arrangement at a 90°[18]. One possible explanation for the absence of difference between them lies in the stress distribution related to different models of fixation. A study availed stress distribution in different techniques of SSRO showing the reversed “L” arrangement with more homogeneous load distribution among the screws, although one part of the stress was directed to the thinner bone area: the anterior area of the proximal segment[18]. This region, according to Obeid and Linquist[29], is the most fragile owing to the low bone thickness and increasing the stress concentrated around the attachment system screws.

Whit bicortical screw, the threads of the screw should engage in the buccal side as well as in lingual side. Obeid and Linquist[29], developed an anatomic study of human cadaveric mandibles to assess bone thickness, showed that the thickest cortical bone on buccal area were in the superior border of the ramus, just distal to the last molar. These results oriented other mechanical experiments about the best bone available for the placement of bicortical screw[30]. Invariably, the posterior region was indicated as the region of choice to provide the best quality and width of bone[31]. In our results, was no showed statically significance between thickness buccal or lingual cortical zone; different results were reported by Smith *et al*.[28], although this difference in the measurement of cortical bone, can be explained by greater accuracy in the measurement obtained by cone-beam computed tomography; for other hand, our results demonstrate that the cortical plates (buccal or lingual) no showed significantly differences in thicker of superior or inferior border of mandible. Cortical bone thickness has been shown to be one of many factors affecting screw pullout strength and, consequently, the holding power of the screw[32]. As cortical bone thickness increases, so does the screw pullout strength. In this direction, based in our result, bicortical screw presented 3mm at least for insertion in cortical area, been a minimum 9mm length for cover the full width of mandible in superior area. If a gap is observed between the distal or proximal segment, should be necessary more length screw.

CONCLUSION

The cortical thickness the mandibular ramus is particularly strong and offers a good anchorage for SSRO using osteosynthesis screws independently of osteosynthesis technique.

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CONCLUSÃO:

No presente estudo de acordo com a metodologia empregada podemos concluir que:

1- A espessura da cortical do ramo mandibular é suficiente para oferecer boa ancoragem para osteotomia sagital do ramo mandibular utilizando parafusos independente da disposição da fixação.

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ANNEX

COMITÊ DE ÉTICA EM PESQUISA
FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa "**Qualidade óssea do complexo maxilomandibular através das imagens da radiografia panorâmica digital e da tomografia computadorizada de feixe cônico: Validação da classificação de Klemetti**", protocolo nº **138/2009**, dos pesquisadores **MARIA BEATRIZ CARRAZZONE CAL ALONSO e PLAUTO CHRISTOPHER ARANHA WATANABE**, satisfaz as exigências do Conselho Nacional de Saúde – Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 28/10/2009.

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project "**Bone quality of maxillomandibular complex using images of panoramic radiographs and cone beam computed tomography: Validating of Klemetti index**", register number **138/2009**, of **MARIA BEATRIZ CARRAZZONE CAL ALONSO and PLAUTO CHRISTOPHER ARANHA WATANABE**, comply with the recommendations of the National Health Council – Ministry of Health of Brazil for research in human subjects and therefore was approved by this committee at 28/10/2009.

Prof. Pablo Agustin Vargas
Secretário
CEP/FOP/UNICAMP

Prof. Jacks Jorge Júnior
Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo aparece como fornecido pelos pesquisadores, sem qualquer edição.
Notice: The title of the project appears as provided by the authors, without editing.