Pesquisa Brasileira em Odontopediatria e Clínica Integrada 2024; 24:e230187
https://doi.org/10.1590/pboci.2024.075
ISSN 1519-0501 / eISSN 1983-4632

ORIGINAL ARTICLE

Anatomical Considerations for Clinical Predictability in Intraoral Defect Reconstruction: A Morphometric Study

Gabriely Ferreira[1], François Isnaldo Dias Caldeira[1], Lívia Nordi Dovigo[2], Eduardo Cotecchia Ribeiro[3], Paulo Domingos André Bolini[1], Marcelo Silva Monnazzi[1]

[1]Department of Diagnosis and Surgery, School of Dentistry of Araraquara, Paulista State University, Araraquara, SP, Brazil.
[2]Departament of Social Dentistry, School of Dentistry of Araraquara, Paulista State University, Araraquara, SP, Brazil.
[3]Department of Morphology and Genetics, Paulista School of Medicine, Federal University of São Paulo, São Paulo, SP, Brazil.

Corresponding author: Gabriely Ferreira **E-mail:** gabriely.ferreira@unesp.br

Academic Editor: Wilton Wilney Nascimento Padilha

Received: September 23, 2023 / **Review:** December 18, 2023 / **Accepted:** January 26, 2024

How to cite: Ferreira G, Caldeira FID, Dovigo LN, Ribeiro EC, Bolini PDA, Monnazzi MS. Anatomical considerations for clinical predictability in intraoral defect reconstruction: A morphometric study. Pesqui Bras Odontopediatria Clín Integr. 2024; 24:e230187. https://doi.org/10.1590/pboci.2024.075

ABSTRACT
Objective: To analyze morphometric measurements in dry jaws, chins, and hip bones to contribute to clinical predictability in the reconstruction of grafted areas. **Material and Methods:** The sample comprised 619 anatomical specimens. Anatomical structures were measured at predetermined points using a digital vernier caliper. Measurements of average thickness and linear dimensions of the coronoid process, as well as the average thickness of the mentum and iliac crest points, were obtained. **Results:** The average morphometric measurements of anatomical structures revealed that male individuals exhibit larger values than female individuals, with a mean difference of 1.57 mm. The mean estimated bone volume of the iliac crest and iliac fossa was 21,347.19 mm^3 and 21,125.56 mm^3 for the left and right sides, respectively. The coronoid process displayed a smaller thickness (2.11 mm) and linear measurement (5.77 mm) in its upper portion and a larger thickness (3.63 mm) and linear measurement (14.51 mm) at its base, on average. In the mentum, the greatest average thickness was found at the midline, with a value of 12.90 mm. **Conclusion:** The surgeon can predict the amount of bone that can be obtained from donor areas, as well as the predominant type of bone in each area, aiming to optimize its clinical application. It is important to highlight that both the iliac crest and iliac fossa provide a significant bone volume in comparison to intraoral areas.

Keywords: Dental Implants; Therapeutics; Bone Transplantation; Mandible; Hip.

Introduction

Since Branemark's discovery of osseointegration, there has been a growing interest among patients in oral rehabilitation with dental implants [1-4]. This shift occurred due to the high clinical success rate of these procedures, encouraging professionals to enhance their techniques in bone grafting and implant placement in maxillary bones [3,5].

Among the reconstruction needs of these structures, bone defects in the height and width of the alveolar processes stand out, which can be caused by pathological processes, traumas, and traumatic dental extractions [6-8]. According to Araújo et al. [9], the goal of alveolar bone reconstruction is to enable the safe installation of implants in the affected areas while meeting the patient's aesthetic needs.

Although there are various grafting techniques in dentistry, the use of autogenous bone grafts is still the first-choice option for professionals due to their ideal biological properties and biocompatibility with the recipient area [10,11]. Additionally, autogenous bone grafts possess osteogenic, osteoinductive, and osteoconductive properties. The type of graft can be obtained from various donor areas, both intraoral and extraoral, depending on the patient's clinical needs [12].

The use of grafts from the mental region and the coronoid process has been successfully employed to reconstruct small defects in the maxillary bones [13]. This donor region allows the professional to obtain an adequate amount of bone tissue from the surgical area, presenting low cost and morbidity for the patient [14].

However, for large reconstructions of the maxilla, the amount of bone tissue required as a substrate for grafting is often a limiting factor for using intraoral donor areas [11]. Therefore, depending on the size of the defect to be reconstructed, the use of extraoral grafts becomes an excellent option. In this regard, the anterior iliac crest bone has been successfully used for large maxillary reconstructions due to its relative morbidity and the possibility of obtaining a significant amount of bone tissue, both cortical and medullary [15,16].

Considering the several gaps in knowledge on the subject, the main objective of this study was to analyze morphometric measurements in dry hip bones, jaws, and chins that can contribute to clinical predictability in the reconstruction of intraoral defects.

Material and Methods

Study Design and Ethical Clearance

For this non-analytical cross-sectional observational study, the STROBE checklist (Strengthening the reporting of observational studies in epidemiology) was employed [17]. This study was approved by the Research Ethics Committee (CAAE: 46683315.2.3001.5505).

Sampling

Dry mandibles and pelvic bones available at the Department of Anatomy at the Federal University of São Paulo, School of Dental Medicine, Campus São Paulo, and at the Department of Morphology of São Paulo State University, School of Dentistry, Araraquara, were used. The samples used in this study originated from the entire collection of these institutions, including only 22 hip bones, 294 jaws, and 303 chins.

All mandibles and hip bones used were from individuals aged 18 and above of both sexes and races, present in the laboratories were included. Additionally, other anatomical structures, such as pieces with fractures in the areas of analysis, markings, or any type of wear that could potentially interfere with the accuracy of the measurements, were excluded from the study.

Data Collection

The dependent variables considered were measurements, in millimeters, of predetermined points of the mandibular coronoid process, mentum, anterior and posterior regions of the iliac crest, and iliac fossa located in the hip bone.

The measurements, in millimeters, were performed using two digital calipers: one unmodified (150mm Absolute Series 500, Mitutoyo Corp., Kanagawa, Japan) and another with modifications (150mm Model 01.0004, Zaas Precision), both with an accuracy of ± 0.02 mm according to the manufacturers. The modified caliper had bilateral devices added to both the fixed and mobile measuring arms to enable measuring the thickness of the structures.

The coronoid processes were measured in terms of width, thickness, and height using the unmodified caliper. Regarding thickness and width, measurements were taken at three points. Point A was defined as the point at the upper portion of the coronoid process, standardized 2 mm below its apex; point B was the midpoint between points A and C (in the distance between the points); point C was the point at the base of the coronoid process. All measurements were taken bilaterally. The height was measured from the apex of the coronoid process to its base.

Regarding the mentum, thicknesses were measured at five points using the modified caliper. Point A was defined in the midline region of the mentum, 10 mm above the base of the mandible. Point C1 at the same height but 10 mm from the anterior border of the mental foramen on the right side of the mandible. Point B1 was also at the same height as the previous points (A and C1), but halfway between them. Points B2 and C2 were the same as B1 and C1 but on the left side of the mandible.

Dry hip bones were also measured, using a modified caliper, in the anterior and posterior regions of the iliac crests and the iliac fossa at 12 points. The measured points were AS, in the iliac crest region (measured in thickness), located 30 mm from the most anterior and superior region. Point AM, located 30 mm from the most anterior region of the iliac crest and 22.5 mm below point AS. Point AI, 22.5 mm below point AM. Point BS, located 2 cm posterior to point AS. Point BM, 2 cm posterior to point AM and 22.5 mm below point BS. Point BI, 2 cm posterior to point AI and 22.5 mm below point BM. Point CS, located 2 cm posterior to point BS. Point CM, 2 cm posterior to point BM and 22.5 mm below point CS. Point CI, 2 cm posterior to point BI and 22.5 mm below point CM. Point DS, located 2 cm posterior to point CS. Point DM, located 2 cm posterior to point CM and 22.5 mm below point DS. Point DI, 2 cm posterior to point IC and 22.5 mm below point DM.

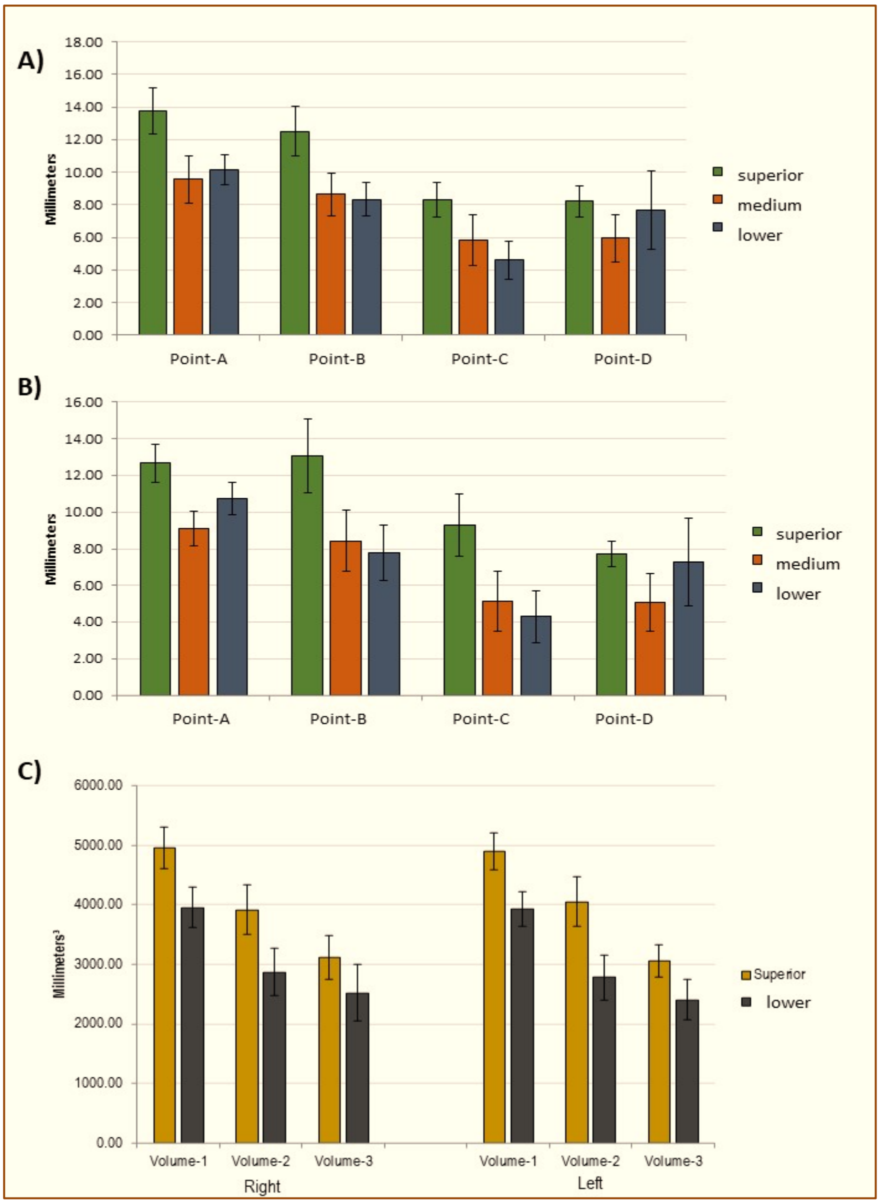
To assess the intra-examiner reliability of the obtained measurements, a reproducibility study was conducted. The Intraclass Correlation Coefficient (ICC; ρ) and its 95% Confidence Interval (95% CI) are presented in Table 1 and 5 of the supplementary material [18].

Data Analysis

Initially, a descriptive analysis of the data was performed. Then, the Shapiro-Wilk test was applied to verify the assumption of normality in all measurement groups at each point. The 95% confidence intervals were estimated considering the Student's t-distribution. For the evaluation of the morphometric measurements of the iliac crest, bone volumes were estimated for each bone portion, considering the formation of six parallelepipeds (these estimates were calculated for rectilinear surfaces). For the coronoid process, measurements of side (left/right), gender (male/female), and age groups were considered. For this analysis, the Statistical Package for the Social Sciences software (IBM Corp., Armonk, NY, USA) was used with a significance level of 5%.

Results

Figure 1 depicts the morphometric measurements from different anatomical points taken on the iliac crest of human skeletons.

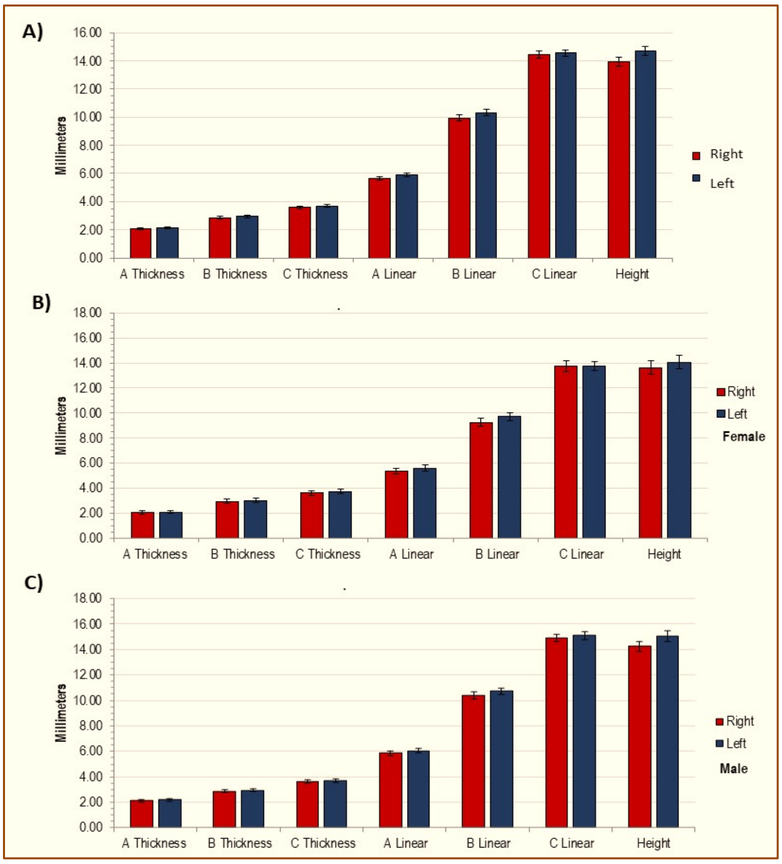


The values were obtained through means and confidence intervals (CI 95%).

Figure 1. Morphometric measurements of different anatomical points were performed on the hip bone (iliac crest). A: Represents the measurements related to the right iliac crest; B: Represents the measurements related to the left iliac crest: Anatomical points evaluated on the iliac crest as described in the materials and methods section, and C: Represents the estimated volume of thickness measurements performed on the iliac crest.

Concerning clinical findings, it can be observed that in the upper region of the iliac crest, the thickness of points A (Figure 1A: Superior= 13.74±2.24mm, medium= 9.54±2.29mm, and lower= 10.12±1.44mm; Figure 1B: Superior= 16.68±1.62mm, medium= 9.08±1.47mm, and lower= 10.72±1.39mm) and B (Figure 1A: Superior=12.5±2.38mm, medium= 8.63±2.04mm, and lower= 8.34±1.62mm; Figure 1B: Superior= 13.08±3.18mm, medium= 8.42±2.61mm, and lower= 7.79±2.38mm) was significantly greater than the thickness of points C (Figure 1A: Superior= 8.32±1.68mm, medium= 5.84±2.43mm, and lower= 4.59±1.79mm; Figure 1B: Superior= 9.31±2.67mm, medium= 5.14±2.57mm, and lower= 4.29±2.25mm) and D (Figure 1A: Superior= 8.21±1.47mm, medium= 5.96±2.29mm, and lower= 7.67±3.82mm; Figure 1B: Superior= 7.69±1.08mm, medium= 5.07±2.44mm, and lower= 7.27±3.75mm) for both sides considered. Furthermore, for all points, the difference between the means of the right and left sides was not significant. The mean estimated total bone volume, determined by summing the volume of each parallelepiped, was 21,347.19 mm³ and 21,125.56 mm³ for the left and right sides, respectively (95% CI left = 19,516.96 - 22,734.16 mm³; 95% CI right = 19,297.31 - 23,397.06 mm³).

Figure 2 represents the clinical findings of measurements related to the coronoid process. The minimum and maximum dimensions, both in thickness (A-Thickness= 2.11±0.59mm, B-Thickness= 2.91±0.74mm, and C-Thickness= 3.63±0.92mm) and linear (A-Linear= 5.77±1.18mm, B-Linear= 10.14±1.84mm, and C-Linear= 14.51± 2.13mm) measurements, can be observed in Figure 2A.



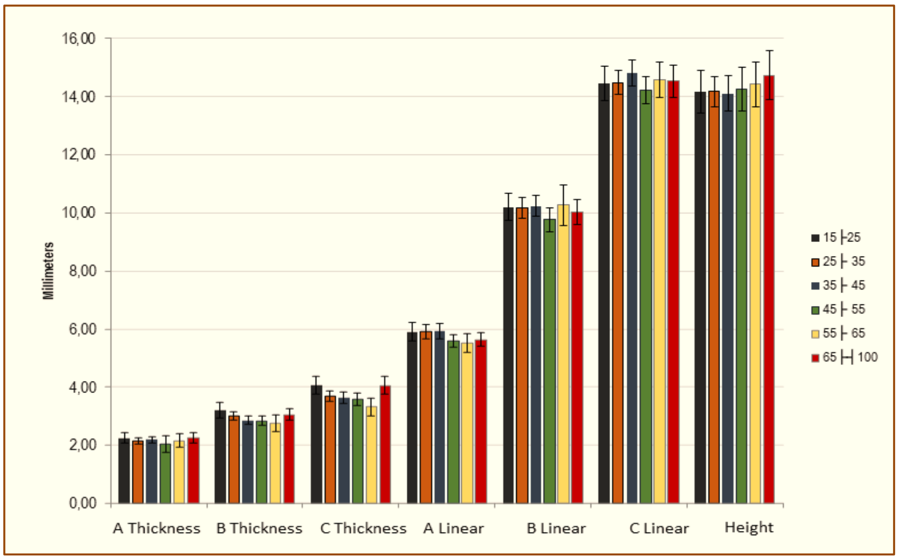
The values were obtained through means and confidence intervals (95% CI).

Figure 2. Morphometric measurements of different anatomical points were performed on the coronoid process. A: Represents the measurements of the coronoid process at different points on the left and right sides; B: Represents the measurements of the coronoid process at different points on the left and right sides in female individuals; and C: Represents the measurements of the coronoid process at different points on the left and right sides in male individuals.

The larger measurements in relation to gender were distributed as follows: Female – Right (C-Thickness= 3.60±0.99mm; C-Linear: 13.77±2.06mm) and Left (C-Thickness= 3.78±0.88mm; C-Linear: 13.74±1.77mm), represented in Figure 2B. Figure 2C characterizes the measurements of the male gender - Right (C-Thickness= 3.62±0.92mm; C-Linear: 14.90±2.10mm) and Left (C-Thickness= 3.67±0.90mm; C-Linear:

15.07±2.09mm). However, no significant differences were observed regarding measurements and the gender of the studied population.

When evaluating the relationship between the age of the population and the analyzed parameters, it can be seen that individuals between 35 and 45 years (according to information provided by the evaluated dataset) presented the largest linear measurements (A-Linear= 5.92±0.27mm, B-Linear= 10.23±0.35mm, and C-Linear= 14.79±0.44mm) and thickness (A-Thickness= 2.19±0.11mm, B-Thickness= 2.86±0.13mm, and C-Thickness= 3.62±0.19mm) of bone (Figure 3).



The values were obtained through means and confidence intervals (95% CI).

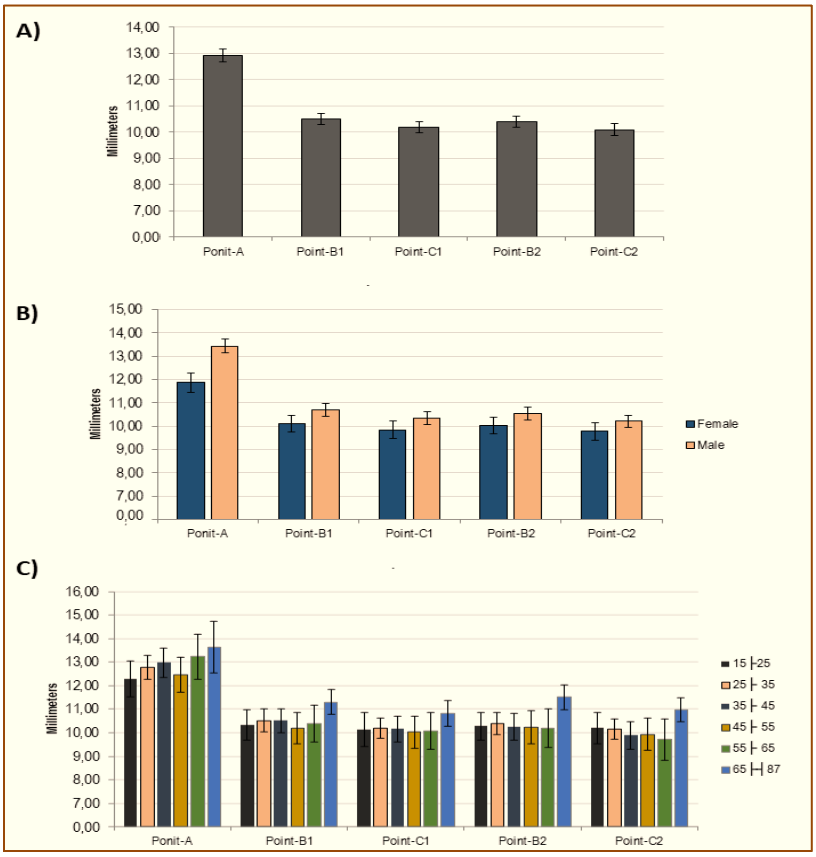
Figure 3. Represents the measurements of the coronoid process at different points on the left and right sides in individuals of different age groups.

Figure 4 represents morphometric data related to chin measurements. The results revealed that the thickest bone was measured at point A (12.90±2.21mm) on the chin compared to point C2 (10.09±1.90mm), which exhibited thinner bone. On average, points B1, B2, C1, and C2 showed thickness values 2.61 mm lower than point A (Figure 4A).

Regarding gender, it can be observed that men at point A (13.43±0.28mm) had greater bone tissue thickness compared to women (11.86±0.41mm). When stratifying anatomical points by gender, it is visually evident from Figure 4B that point A had higher values of bone tissue thickness on the chin.

Analyzing the relationship between the age of the evaluated population and the analyzed anatomical points, it was observed that the age group of 35 to 45 years showed greater bone thickness measurements on the chin (Point A= 12.97±0.63mm, Point B1= 10.51±0.51mm, Point B2=10.24±0.57mm, Point C1=10.15±0.54mm, and Point C2=9.89±0.58mm) (Figure 4C).

Figure 5 represents the overall mean values of the evaluated anatomical structures. In the schematic axial section of the mentum (Figure 5A), the respective mean thickness values in millimeters at each evaluated point were observed from left to right: C1 (10.19 mm), B1 (10.51 mm), A (12.90 mm), B2 (10.38 mm), and C2 (10.09 mm). When analyzing the mandibular coronoid process in the upper portion of the diagram (Figure 5B), the measurements of width (5.77; 10.14; 14.51 mm), height (14.33 mm), and thickness of the coronoid process (2.11; 2.91; 3.63 mm) were respectively represented. Figure 5C presents the measurements obtained from the hip bones, showing that the mean height was approximately 45 mm and the width was 60 mm.



The values were obtained through means and confidence intervals (95% CI).

Figure 4. Morphometric measurements of different anatomical points were performed on the human mandible. A: Represents measurements related to the mentum according to different evaluated points; B: Represents measurements related to the mentum according to different evaluated points and the relationship between gender; and C: Represents measurements related to the mentum according to different evaluated points in individuals of different age groups.

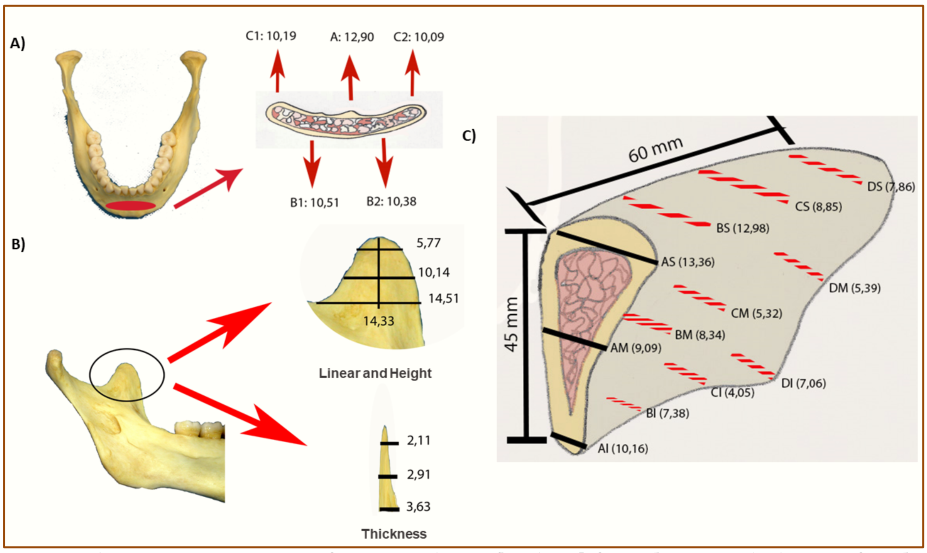


Figure 5. **Representative measurements of mean values obtained from human skeletons for the iliac crest, mentum, and coronoid process. A: Represents a superior view of a cross-sectional cut of the mentum exemplifying the mean values found at the evaluated points, in millimeters; Figure B: Represents the mean values of the lateral and frontal views of the coronoid process in millimeters; and C: Represents the evaluated bony fragment from the anterior iliac crest, showing the mean values found at the evaluated points (in millimeters) and the dimensions of the fragment evaluated in centimeters.**

Discussion

Although there are several studies investigating the morphometric role in predicting grafted areas, to the best of our knowledge, this is the first study that simultaneously evaluates these donor areas in human skeletons [1,19,20]. The discussion around anatomical characteristics and bone variations is of great importance in clinical practice, as this information aids in surgical planning and achieving precise outcomes in intraoral grafted areas [21].

When evaluating morphometric measurements between genders in the studied population, it was possible to identify that female individuals presented smaller dimensions among the evaluated structures compared to male individuals. However, no statistically significant differences were found for these predictor variables. Variation in results when analyzing gender differences in the population is not uncommon. These findings can be explained by previous studies on sexual dimorphism, which have demonstrated differences in measurements of anatomical structures between men and women [22-25]. Demonstrating that men have higher overall averages in anatomical parameters than women.

Regarding the morphometric measurements obtained from the iliac crest in human skeletons, our investigation's results agree with those of other studies published in the literature. A relevant example is the study conducted by Ebraheim et al. [26], which aimed to morphologically analyze the anterior iliac crest in 30 skeletons and 10 cadavers. Their results showed that iliac crest bones are ideal for grafting intraoral recipient areas.

Analyzing our data regarding the volume of the anterior region of the iliac crest, we found conflicting results among authors. Interestingly, this fact can be observed in the study by Burk et al. [27], which evaluated the maximum volume of available bone in the iliac crest in cadavers for surgical approaches. Their results demonstrated that the average amount of surgically removable bone could reach 26.29 mL (26,290 mm^3) in uncompressed bone and 20.58 mL (20,580 mm^3) in compressed bone. However, in our study, we observed a volume above most reported in the literature. One possible cause for this variability is associated with the evaluated anatomical surfaces, such as measurements of the anterior, posterior, and straight fossa of the iliac crest for volume calculation. As it is an irregular bone, this can lead to inaccuracies in the estimation of bone volume when compared to the actual volume.

In the present study, we evaluated the measurements of the mandibular coronoid process. Considering the entire population evaluated, the overall mean of these measurements was: width (5.77; 10.14; 14.51 mm), height (14.33 mm) and thickness (2.11; 2.91; 3.63 mm). Consistently, a study conducted by Yates et al. [28] compared the amount of available bone in 59 cadaver skulls. Their results demonstrated that the coronoid process of the mandible in cadavers presented, at the thickest region, an average value of 3.08 mm. These findings can be reaffirmed by our study involving jaws.

When evaluating the mental region of the skeletons, we identified a greater cortical bone thickness at point A (from the mental spine to the mental protuberance). However, the studies by Park et al. [29] and Lee et al. [30] showed different results from those found in our investigation. This discrepancy can be explained by methodological differences in assessing these structures, as they were conducted through computed tomography.

Surgery for implant placement has gained significant prominence in recent years [31,32]. In this context, bone grafts have become a fundamental tool, increasingly employed to create optimal conditions for the installation of these implants [33]. The meticulous assessment of the donor site, through precise measurements taken with a caliper, not only enables the quantification of thickness but also provides the opportunity to determine the volume of the region. This careful mapping aims to guide the surgeon in choosing the most appropriate approach for maxillary reconstruction procedures.

This detailed approach to the donor area is essential to optimize surgical outcomes, providing a solid and personalized foundation for implant success and, consequently, patient satisfaction [34]. Therefore, morphometric studies become necessary to understand clinical predictability and determine the best donor area that minimizes the impact on post-surgical quality of life for the patient. This is particularly relevant as the use of autogenous grafts presents both advantages and disadvantages in terms of clinical predictability [34]. A comprehensive understanding of these aspects will contribute to a more informed and effective surgical practice, promoting better outcomes and satisfaction for both professionals and patients.

The present study has some limitations that should be mentioned. Firstly, the sample size of evaluated individuals (human skeletons) was limited, which may influence the generalization of the results. Additionally, we found discrepancies in the literature regarding the units of measurement of the evaluated structures, as well as the employed methodologies. We also faced physical difficulties in finding a collection with preserved and intact structures for evaluation, as well as demographic information of the skeletons, such as gender and age. The morphological irregularity of the evaluated points may have also impacted the precision of the results, especially regarding the volume of the assessed area. Another limitation is the scarcity of works in the literature that use standardized methodologies for morphometric studies in this specific context. However, it is important to highlight that our study addressed a relevant clinical theme, i.e., the predictability of donor areas for intraoral grafts. The dental literature is still scarce in this area, highlighting the importance of investigations in this field. We acknowledge that more morphometric studies, including a larger cohort, are necessary to expand knowledge and understanding of these structures.

Conclusion

It is important to highlight that both the iliac crest and iliac fossa provide a significant bone volume compared to intraoral areas. However, it is important to note that the discrepancy in volume values of the anterior, posterior, and fossa iliac regions may be related to the different methodologies used in the studies present in the literature. Therefore, conducting future studies with a larger cohort is necessary to more accurately assess these morphometric measurements and, consequently, obtain more homogeneous results.

Authors' Contributions

GF	https://orcid.org/0000-0002-4102-0038	Conceptualization, Methodology, Formal Analysis, Investigation and Writing - Original Draft.
FIDC	https://orcid.org/0000-0002-4688-2059	Writing - Original Draft.
LND	https://orcid.org/0000-0002-5435-7609	Formal and Writing - Review and Editing.
ECR	https://orcid.org/0009-0005-8708-4212	Writing - Review and Editing.
PDAB	https://orcid.org/0009-0005-7209-8056	Data Curation and Writing - Review and Editing.
MSM	https://orcid.org/0000-0001-6142-4630	Conceptualization, Methodology, Formal Analysis, Investigation, Writing - Review and Editing and Project Administration.

All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

Financial Support

None.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

References

[1] Hall MB, Vallerand WP, Thompson D, Hartley G. Comparative anatomic study of anterior and posterior iliac crests as donor sites. J Oral Maxillofac Surg 1991; 49(6):560-563. https://doi.org/10.1016/0278-2391(91)90335-j

[2] Wakankar J, Mangalekar SB, Kamble P, Gorwade N, Vijapure S, Vhanmane P. Comparative evaluation of the crestal bone level around pre- and post-loaded immediate endoosseous implants using cone-beam computed tomography: A clinico-radiographic study. Cureus 2023; 15(2):e34674. https://doi.org/10.7759/cureus.34674

[3] Sanz I, Garcia-Gargallo M, Herrera D, Martin C, Figuero E, Sanz M. Surgical protocols for early implant placement in post-extraction sockets: A systematic review. Clin Oral Implants Res 2012; 23(Suppl 5):67-79. https://doi.org/10.1111/j.1600-0501.2011.02339.x

[4] Branemark PI. Osseointegration and its experimental background. J Prosthet Dent 1983; 50(3):399-410. https://doi.org/10.1016/s0022-3913(83)80101-2

[5] Branemark PI, Hansson BO, Adell R, Breine U, Lindstrom J, Hallen O, et al. Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. Scand J Plast Reconstr Surg Suppl 1977; 16:1-132.

[6] D'Orto B, Chiavenna C, Leone R, Longoni M, Nagni M, Cappare P. Marginal bone loss compared in internal and external implant connections: Retrospective clinical study at 6-years follow-up. Biomedicines 2023; 11(4):1128. https://doi.org/10.3390/biomedicines11041128

[7] Aghaloo T, Pi-Anfruns J, Moshaverinia A, Sim D, Grogan T, Hadaya D. The effects of systemic diseases and medications on implant osseointegration: A systematic review. Int J Oral Maxillofac Implants 2019; 34:s35-s49. https://doi.org/10.11607/jomi.19suppl.g3

[8] Cheung MC, Hopcraft MS, Darby IB. Dental implant hygiene and maintenance protocols: A survey of oral health practitioners in Australia. J Dent Hyg 2021; 95(1):25-35.

[9] Araújo PP, Oliveira KP, Montenegro SC, Carreiro AF, Silva JS, Germano AR. Block allograft for reconstruction of alveolar bone ridge in implantology: A systematic review. Implant Dent 2013; 22(3):304-308. https://doi.org/10.1097/ID.0b013e318289e311

[10] Zhang S, Li X, Qi Y, Ma X, Qiao S, Cai H, et al. Comparison of autogenous tooth materials and other bone grafts. Tissue Eng Regen Med 2021; 18(3):327-341. https://doi.org/10.1007/s13770-021-00333-4

[11] Canullo L, Pesce P, Antonacci D, Ravida A, Galli M, Khijmatgar S, et al. Soft tissue dimensional changes after alveolar ridge preservation using different sealing materials: a systematic review and network meta-analysis. Clin Oral Investig 2022; 26(1):13-39. https://doi.org/10.1007/s00784-021-04192-0

[12] Chatelet M, Afota F, Savoldelli C. Review of bone graft and implant survival rate: A comparison between autogenous bone block versus guided bone regeneration. J Stomatol Oral Maxillofac Surg 2022; 123(2):222-227. https://doi.org/10.1016/j.jormas.2021.04.009

[13] Jafarian M, Dehghani N. Simultaneous chin onlay bone graft using elongated coronoid in the treatment of temporomandibular joint ankylosis. J Craniofac Surg 2014; 25(1):e38-44. https://doi.org/10.1097/SCS.0b013e3182a2ee26

[14] Sabhlok S, Waknis PP, Gadre KS. Applications of coronoid process as a bone graft in maxillofacial surgery. J Craniofac Surg 2014; 25(2):577-580. https://doi.org/10.1097/SCS.0000000000000624

[15] Sethi A, Kaus T, Cawood JI, Plaha H, Boscoe M, Sochor P. Onlay bone grafts from iliac crest: A retrospective analysis. Int J Oral Maxillofac Surg 2020; 49(2):264-271. https://doi.org/10.1016/j.ijom.2019.07.001

[16] Ma G, Wu C, Shao M. Simultaneous implant placement with autogenous onlay bone grafts: A systematic review and meta-analysis. Int J Implant Dent 2021; 7(1):61. https://doi.org/10.1186/s40729-021-00311-4

[17] Cuschieri S. The STROBE guidelines. Saudi J Anaesth 2019; 13(Suppl 1):S31-S34. https://doi.org/10.4103/sja.SJA_543_18

[18] Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 2016; 15(2):155-163. https://doi.org/10.1016/j.jcm.2016.02.012

[19] Ghassemi A, Schreiber L, Prescher A, Modabber A, Nanhekhan L. Regions of ilium and fibula providing clinically usable bone for mandible reconstruction: "A different approach to bone comparison". Clin Anat 2016; 29(6):773-778. https://doi.org/10.1002/ca.22732

[20] Aalam AA, Nowzari H. Mandibular cortical bone grafts part 1: Anatomy, healing process, and influencing factors. Compend Contin Educ Dent 2007; 28(4):206-212; quiz 13.

[21] Derks J, Ortiz-Vigon A, Guerrero A, Donati M, Bressan E, Ghensi P, et al. Reconstructive surgical therapy of peri-implantitis: A multicenter randomized controlled clinical trial. Clin Oral Implants Res 2022; 33(9):921-944. https://doi.org/10.1111/clr.13972

[22] Keidan L, Barash A, Lenzner Z, Pick CG, Been E. Sexual dimorphism of the posterior cervical spine muscle attachments. J Anat 2021; 239(3):589-601. https://doi.org/10.1111/joa.13448

[23] Scendoni R, Kelmendi J, Arrais Ribeiro IL, Cingolani M, De Micco F, Cameriere R. Anthropometric analysis of orbital and nasal parameters for sexual dimorphism: New anatomical evidences in the field of personal identification through a retrospective observational study. PLoS One 2023; 18(5):e0284219. https://doi.org/10.1371/journal.pone.0284219

[24] Dean D, Hans MG, Bookstein FL, Subramanyan K. Three-dimensional bolton-brush growth study landmark data: Ontogeny and sexual dimorphism of the Bolton standards cohort. Cleft Palate Craniofac J 2000; 37(2):145-156. https://doi.org/10.1597/1545-1569_2000_037_0145_tdbbgs_2.3.co_2
[25] Marcus S, Whitlow CT, Koonce J, Zapadka ME, Chen MY, Williams DW, 3rd, et al. Computed tomography supports histopathologic evidence of vestibulocochlear sexual dimorphism. Int J Pediatr Otorhinolaryngol 2013; 77(7):1118-1122. https://doi.org/10.1016/j.ijporl.2013.04.013
[26] Ebraheim NA, Yang H, Lu J, Biyani A, Yeasting RA. Anterior iliac crest bone graft. Anatomic considerations. Spine 1997; 22(8):847-849. https://doi.org/10.1097/00007632-199704150-00003
[27] Burk T, Del Valle J, Finn RA, Phillips C. Maximum quantity of bone available for harvest from the anterior iliac crest, posterior iliac crest, and proximal tibia using a standardized surgical approach: A cadaveric study. J Oral Maxillofac Surg 2016; 74(12):2532-2548. https://doi.org/10.1016/j.joms.2016.06.191
[28] Yates DM, Brockhoff HC, 2nd, Finn R, Phillips C. Comparison of intraoral harvest sites for corticocancellous bone grafts. J Oral Maxillofac Surg 2013; 71(3):497-504. https://doi.org/10.1016/j.joms.2012.10.014
[29] Park HD, Min CK, Kwak HH, Youn KH, Choi SH, Kim HJ. Topography of the outer mandibular symphyseal region with reference to the autogenous bone graft. Int J Oral Maxillofac Surg 2004; 33(8):781-785. https://doi.org/10.1016/j.ijom.2004.02.006
[30] Lee JE, Lee YJ, Jin SH, Kim Y, Kook YA, Ko Y, et al. Topographic analysis of the mandibular symphysis in a normal occlusion population using cone-beam computed tomography. Exp Ther Med 2015; 10(6):2150-2156. https://doi.org/10.3892/etm.2015.2842
[31] Emami E, Heydecke G, Rompré PH, de Grandmont P, Feine JS. Impact of implant support for mandibular dentures on satisfaction, oral and general health-related quality of life: A meta-analysis of randomized-controlled trials. Clin Oral Implants Res 2009; 20(6):533-544. https://doi.org/10.1111/j.1600-0501.2008.01693.x
[32] Gonçalves GSY, de Magalhães KMF, Rocha EP, Dos Santos PH, Assunção WG. Oral health-related quality of life and satisfaction in edentulous patients rehabilitated with implant-supported full dentures all-on-four concept: A systematic review. Clin Oral Investig 2022; 26(1):83-94. https://doi.org/10.1007/s00784-021-04213-y
[33] Zhao R, Yang R, Cooper PR, Khurshid Z, Shavandi A, Ratnayake J. Bone grafts and substitutes in dentistry: A review of current trends and developments. Molecules 2021; 26(10):3007. https://doi.org/10.3390/molecules26103007
[34] Sakkas A, Wilde F, Heufelder M, Winter K, Schramm A. Autogenous bone grafts in oral implantology-is it still a "gold standard"? A consecutive review of 279 patients with 456 clinical procedures. Int J Implant Dent 2017; 3(1):23. https://doi.org/10.1186/s40729-017-0084-4