

Quality and Success of Bone Graft from Two Different Mandibular Sites Compared for Maxillary Ridge Augmentation: A Systematic Review

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ABSTRACT

Aim: This systematic review was undertaken to compare the quality of autogenous bone graft harvested from two different mandibular donor sites, that is, from the chin region and from posterior mandibular region for maxillary alveolar ridge augmentation and success after implant placement.

Materials and methods: Systematic searches were performed using PubMed, MEDLINE, and Cochrane electronic databases, which reported on the quality of autogenous harvested bone graft of the recipient site in maxillary alveolar ridge augmentation from a period of January 1995 to December 2020 using PRISMA guidelines. Studies were included if: They reported on bone grafts harvested from the chin and body region of the mandible. Time and nature of postoperative complications were reported. Quality comparison of autogenous bone graft from both chin and posterior mandible was done from the analysis of extracted data of all articles. The risk of bias was assessed by the Cochrane risk of bias tool and Newcastle-Ottawa Scale.

Results: Out of the eight studies that have been included, five studies concluded that graft from the retromolar region of the mandible produced better quality bone graft compared with graft from the chin region. In contrast, two studies showed the opposite that graft from the chin is better in quality than the graft from the retromolar region. Whereas one study mentioned not being able to find any significant difference in the quality of two grafts. The implant placement also showed a maximum success rate in the retromolar region compared with the chin region in four studies whereas in one study, the success rate was better in the chin region and in three studies, no significant difference could be found in the success rate of implant placement in two different graft regions taken from two different donor sites of the mandible.

Conclusion: This systematic review demonstrates that the retromolar group has shown better results for ridge augmentation in the maxilla compared with the chin group. The retromolar group also produces better and more successful implant placement with fewer chances of failure compared with the chin group.

Clinical significance: In oral surgery, the use of dental implants for partial and complete edentulous jaw rehabilitation is standard procedure. Both hard and soft tissues must be present in adequate quantity and quality for implant dentistry to produce the best results. Patients with resorbed jaws can receive implant-supported restorations by a variety of reconstructive methods, such as tissue regeneration and the use of vascularized or nonvascularized grafts.

Keywords: Autogenous bone graft, Implant placement, Mandibular donor site, Maxillary alveolar ridge augmentation, Retromolar.

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INTRODUCTION

Alveolar ridge deficiencies reconstructed by block bone grafting technique before implant placement is a very common and well-known procedure.¹ Infection, trauma, congenital anomalies, prolonged edentulism, periodontal diseases are the main causes of osseous defects.² Autogenous bone grafts are the gold standard until today for ridge augmentation.³ The common well-known external donor sites also include calvarium, rib, and tibia.^{4,5} Alveolar bone defects repaired with block bone grafts from the symphysis and retromolar, ramus buccal shelf is more advantageous than alveolar bone defects repaired with iliac crest grafts.⁶ The other advantages also include proximity of donor and recipient sites, adequate surgical access, decreased donor site morbidity, and cost-effective.

In order to treat dental implants successfully, a comprehensive and precise planning assessment using radiographic examination is necessary. Cone-beam computed tomography (CBCT) is frequently used in three-dimensional imaging to determine important anatomical features and to evaluate the amount and quality of

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alveolar bone that is accessible for placement.⁷ Resorption of the alveolar ridge, which is either partially or completely edentulous, can jeopardize the proper placement of dental implants for prosthetic purposes. Therefore, to guarantee predictable long-term function and a visually acceptable result, augmentation of insufficient bone volume may be necessary either before or in addition to implant insertion.⁸ Numerous techniques, such as autogenous grafts, xenografts, and alloplastic materials, can be used to increase bone. In terms of biology, autogenous bone grafts are currently considered the gold standard for bone regeneration techniques.⁹ However, the disadvantages of this augmentation procedure include donor site morbidity, variable resorption, scarce supply, and extra surgical sites must be incorporated. In order to achieve informed consent, it is crucial that patients and doctors are aware of the success rates of implants placed in grafted bone at the beginning of treatment, given the possible morbidity associated with autogenous bone grafting.¹⁰

Before deciding to adopt a certain treatment technique, patients should consider the invasiveness of the harvesting process, the possibility of complications, and the morbidity of the donor location. Intraoral donor sites offer several advantages compared with extraoral donor sites, such as convenient surgical accessibility, the proximity of donor and recipient sites, avoidance of cutaneous scarring, and can be performed under local anesthesia on an outpatient basis. The retromolar and the chin region both are known to provide adequate grafting material for the reconstruction of localized alveolar ridge defects. Autogenous bone graft from the retromolar region is characterized by dense to porous compact bone with less amount of cancellous bone, whereas chin bone graft is characterized by dense compact bone with a higher quantity of cancellous bone.¹¹ Thus, the least invasive method with the lowest chance of problems should be used to collect intraoral autogenous bone grafts. Therefore, the aim of the present systematic review was to compare the quality of autogenous bone grafts harvested from two different mandibular donor site, that is, from the chin region and from posterior mandibular region for maxillary alveolar ridge augmentation and success after implant placement.

MATERIALS AND METHODS

The present systematic review was made using PRISMA guidelines with Prospero registration number CRD42024542172. The focused research question of the present study was: Are there any differences in complications and donor site morbidity following harvesting of autogenous bone graft from the retromolar region of mandible compared with the chin (symphysis) region? Following the principles of the patient, intervention, comparison, and outcome (PICO) guidelines, patient and population (P): Healthy patients in need of implant treatment undergoing harvesting of intraoral autogenous bone. Intervention (I): autogenous block bone graft harvested from the mandibular body, retromolar region. Comparator or control group (C): Block bone graft harvested from mandibular chin region. Outcomes (O): Histopathologic study of the graft, OPG or CBCT study reevaluation along with the stability of implant placed in two grafts was considered.

Information Sources

Systematic searches were performed using PubMed, MEDLINE, and Cochrane electronic databases to identify studies which reported on the quality of autogenous harvested bone graft of the recipient site in maxillary alveolar ridge augmentation from a

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Conflict of interest: None

period of January 1995 to December 2020 using PRISMA guidelines. Either keywords categorized under the broad (all fields) category or medical subject headings (MeSH) terms were used as search terms. The search terms were then combined with an "OR," and PICO categories were combined using "AND" to create a final logic search query. Keywords searched for each database were graft from retromolar region AND mandibular chin region. Retromolar mandibular graft OR posterior body of mandible graft AND symphysis of mandible graft OR chin graft.

Eligibility Criteria

Titles of identified reports were initially screened with duplicates removed. Abstracts were assessed when titles indicated that the study was relevant. Full-text analysis was obtained for those with apparent relevance or when the abstract was unavailable.

Studies assessed the quality of autogenous harvested bone graft of the recipient site in maxillary alveolar ridge augmentation, randomized controlled trials with more than five patients, studies which included only bone graft harvested from chin and body region of mandible, studies where assessment of bone graft was done at least after 3 months of follow-up were included in the present review. Studies which include harvested graft material other than mandibular region, studies where allogeneous or xenograft or any other graft material was used, studies where an assessment was done on 5 or less than 5 patients, studies where follow-up period was immediate or less than 3 months, studies based on complications of donor site only, studies done on patients with preexisting systemic conditions were excluded from this review.

A description of the selection procedure was provided by the PRISMA flow diagram (Fig. 1). Duplicates were eliminated from the titles of the discovered reports through screening. When study names suggested that the work was pertinent, abstracts were evaluated. For those that seemed relevant or in cases where the abstract was not available, full-text analysis was obtained. References to recognized papers and previously published systematic reviews evaluating donor site morbidity and complications after autogenous bone graft extraction from the mandibular retromolar region and chin were cross-checked for unidentified publications. Using an Excel sheet for data extraction, the reviewers worked independently. Discussions were used to settle any differences. The information was retrieved, when available, on a standard form for every study that was found and included. The principal investigator performed data extraction which was reviewed thoroughly by another investigator for better reliability. In the event that there were any ambiguities or missing crucial information, the corresponding authors were contacted via e-mail.

Data Items and Study Risk of Bias Assessment

The following data were gathered and organized into the following fields: Patient, complications, year of publication, study design, evaluation of the quality of the harvested bone graft, and implant placement success. Considering these factors, quality assessment was undertaken as a part of the data extraction process. The Cochrane Collaboration's version 5.1.0 of the method for assessing bias risk recommended in the Cochrane Handbook for Systematic

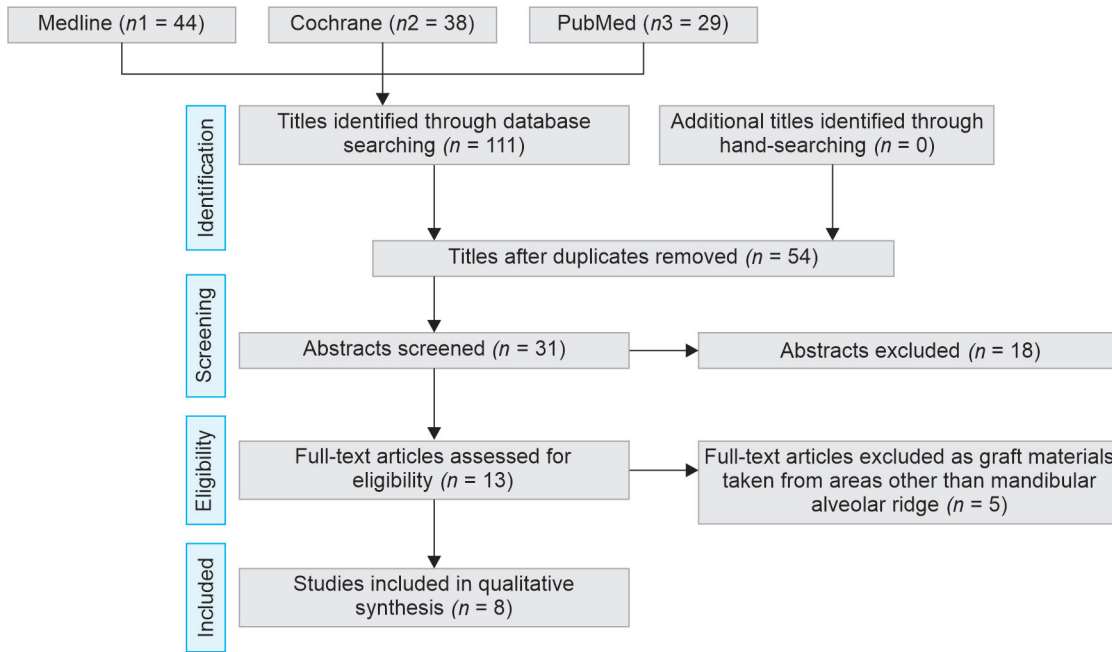


Fig. 1: Data base search in the present study

Reviews of Interventions was applied to the included randomized controlled trials.

Quality Assessment

NHLBI tool for quality assessment was used in this review study. And the scores were as follows: YES-1, NO-2, NA/NR/CD. Quality assessment scoring was decided on the mark above 70% as Good, 50–60% as Fair, and below 50% as poor articles.

RESULTS

Study Selection

The database search identified 111 titles initially. Titles after duplicates removed 54 studies, of which 35 were included. 13 full-text articles assessed for eligibility. Out of 13 articles, 5 were excluded because graft material was taken from areas other than the mandibular alveolar ridge region. Finally included a total of eight articles: Misch CM and Misch CE,¹² Pikos MA,¹³ Raghoobar et al.,¹⁴ Sakkas et al.,¹⁵ Khoshhal et al.,¹⁶ Zhao et al.,¹⁷ Kim S et al.,¹⁸ EL Morsy OA et al.¹⁹

Study Characteristics

All the included studies were randomized control trials and from a period of January 1995 to December 2020. Total number of participants included in the trial was 731. Out of the eight studies that have been included five studies concluded that graft from retromolar region of mandible produced better quality bone graft compared with graft from chin region.^{12–14,16,17} In contrast, two studies said the opposite that graft from chin is better in quality than graft from retromolar region.^{18,19} Whereas one study mention of not being able to find any significant difference in quality of two graft.¹⁵ The implant placement also showed a maximum success rate in the retromolar region compared with the chin region in four studies,^{12–14,16} whereas in one study,¹⁸ the success rate was

better in the chin region and in three studies,^{15,17,19} no significant difference could be found in the success rate of implant placement in two different graft regions taken from two different donor sites of mandible (Tables 1 and 2).

Risk of Bias in Studies

The risk of bias for each included study was analyzed using a standard approach independently by the author. Of the eight RCTs, the randomization method was used by all studies.^{12–19} But the allocation of participants was equal in three studies.^{14,18,19} But in five studies,^{12,13,15–17} the participants allocation was unequal. In five trials, patients and outcome assessors were both blinded, two trials reported that only assessors were blind and one reported that only patients were blind. In four trials, all patients enrolled completed the study, in other four trials, the rate of dropouts was less than 10%.

Quality Assessment Results

Quality for each question as per all articles, that is, Misch and Misch CE,¹² Pikos MA,¹³ Raghoobar et al.,¹⁴ Sakkas et al.,¹⁵ Khoshhal et al.,¹⁶ Zhao et al.,¹⁷ Kim S et al.,¹⁸ and EL Morsy OA et al.¹⁹ found as GOOD (Table 3).

DISCUSSION

The objective of the present systematic review was to test the hypothesis of the difference in the quality of autogenous bone grafts harvested from the body of the mandible compared with the chin region and also the success of implants placed in these harvested grafts. Autogenous bone grafts harvested from the chin region had a much higher prevalence and severity of problems, as well as donor site morbidity, than those harvested from the retromolar region of the mandible. According to the studies, postoperative complications are undesirable or unexpected

Table 1: Characteristics of all included studies

Author and year of publication	Sample size	Donor site in mandible distribution	Recipient site	Implant placement	Follow-up period	Radiographic parameters	Histology parameters	Success of implant placed	Limitations	Conclusion
1. Misch and Misch CM ¹² Pittsburgh, 1995	50	Symphysis-31 Retromandibular-19	Maxillary anterior	Implant placed after 4 months of augmentation	6 months after implant placement	Panoramic radiograph reveals more dense bone marrow formation in retromolar group	-	Success of implant was more in retromolar group than symphysis group	Limited amount of donor bone and potential for damage to nerve branches and lower anterior teeth	Better quality bone graft from body molar retromolar group than chin group
2. Pikos MA, ¹³ USA, 2000	434	Symphysis-208 Retromolar-226	Maxillary anterior	Implant placed after 6 months of augmentation	1 year after implant placement	Panoramic, lateral cephalometric and CT reveals graft dehiscence more in chin with more resorption compared with retromolar group	-	Success of implant was more in retromolar group	Wound site dehiscence results in partial and more often complete graft loss	Better bone graft in retromolar than chin group
3. Raghoobar et al., ¹⁴ Netherlands, 2007	30	Symphysis-15 Retromolar-15	Maxillary anterior	Mini-implant placed after 6 months of augmentation	1 year after implant placement	CBCT shows better bone graft quality of retromolar group than chin. Better acceptance of retromolar graft compared with chin group	-	Success of implant was more in retromolar group	-	Better quality of bone graft in body retromolar group compared with chin group
4. Sakkas et al., ¹⁵ Germany, 2017	97	Symphysis-11 Retromolar-86	Maxillary anterior	Implant placed after 12 months of augmentation	1 year after implant placement	CBCT shows no significant difference was found in quality of graft from the two donor sites	-	No significant difference noted in success of implant placement	This study cannot address the contribution of use of piezoelectric surgery, grafting templates, and guided implant insertion to the reported results, but we could prove that with the described technique, predictable outcome lacking, lasting morbidities can be achieved independently from surgical status such as residents, fellows, or consultants	The low harvesting morbidity of autologous bone grafts, the clinical results of our study indicate that autologous bone grafts still remain the "gold standard" in alveolar ridge augmentation prior to oral implantation

(Contd...)

Table 1: (Contd...)

Author and year of publication	Sample size	Donor site in mandible distribution	Recipient site	Implant placement	Follow-up period	Radiographic parameters	Histology parameters	Success of implant placed	Limitations	Conclusion
5. Khoshhal et al., ¹⁶ Iran, 2016	28	Symphysis-11 Retromolar-17	Maxillary anterior	Implant placed after 6 months of augmentation	6 months after implant placement	CBCT revealed dense trabeculae in retromolar graft group than chin group	-	Implant placement successful more in retromolar group	-	Better quality bone graft of retromolar group of mandible than the chin group
6. Zhao et al., ¹⁷ China, 2021	46	Symphysis-19 Retromolar-27	Maxillary anterior	Implant placed after 6 months of augmentation	1 year after implant placement	CBCT shows more horizontal bone loss in chin graft than body retromolar graft group	-	No difference of success of implant placement could be noted	More standardized preclinical and clinical studies will need to be performed and documented better to understand each material's clinical viability and benefits to introduce more commercially available products	Better quality of bone graft from retromolar compared with the chin
7. Kim S et al., ¹⁸ Korea, 2022	32	Symphysis-16 Retromolar-16	Maxillary anterior	Implant placed after 4 months of augmentation	6 months after implant placement	CBCT revealed better quality of lamellar fibro fatty bone marrow tissue with more reversal lines in chin compared with body group of mandible	-	Implant placement was better in chin group	A convenient and accurate method for decreasing human error was suggested in this study, which can lead to reliable results in future clinical studies	CBCT revealed better quality bone graft from chin compared with body group
8. EL Morsy OA et al., ¹⁹ Egypt, 2020	14	Symphysis-7 Retromolar-7	Maxillary anterior	Implant placed after 4 months of augmentation	6 months after implant placement	CBCT shows better lamellar bone with intervening fibro fatty bone marrow of chin group graft	After Hematoxylin and Eosin staining, the maxillary anterior area sections were observed and HP revealed better bone graft in chin group	No difference in success of implant placement could be found	The design modification was triggered by the very poor bone quality and the massive fibro integration expressed upon the second stage surgery	The virtual planning three-dimensional maxillary alveolar ridge augmentation using patient-specific PEEK sheets deemed successful restoration of the deficient ridge

CBCT, cone-beam computed tomography; HP, histopathology

Table 2: Recording of all eight studies' success of implant placed

<i>Author and year of publication</i>	<i>Donor site</i>	<i>Time after which implant was placed</i>	<i>Success of implant placed</i>
1. Misch CM and Misch CM ¹² 1995	Symphysis Retromolar	4 months	Success of implant was more in retromolar group than symphysis group.
2. Pikos MA ¹³ 2000	Symphysis Retromolar	6 months	Success of implant was more in retromolar group.
3. Raghoobar et al. ¹⁴ 2007	Symphysis Retromolar	6 months	Success of implant was more in retromolar group.
4. Sakkas et al. ¹⁵ 2017	Symphysis Retromolar	1 year	No significant difference noted in success of implant placement.
5. Khoshhal et al. ¹⁶ 2016	Symphysis Retromolar	6 months	Implant placement successful more in retromolar group.
6. Zhao et al. ¹⁷ 2021	Symphysis Retromolar	6 months	No difference of success of implant placement could be noted.
7. Kim S et al. ¹⁸ 2022	Symphysis Retromolar	Immediate implant	Implant placement was better in chin group.
8. EL Morsy OA et al. ¹⁹ 2020	Symphysis Retromolar	6 months	No difference in success of implant placement could be found.

Table 3: The scoring criteria of each study have been done based on present study design

<i>Sl. no</i>	<i>Misch and Misch</i>	<i>Pikos</i>	<i>Raghoobar et al.</i>	<i>Sakkas et al.</i>	<i>Khoshhal et al.</i>	<i>Zhao et al.</i>	<i>Kim S et al.</i>	<i>EL Morsy OA et al.</i>
Qus. 1	1	1	1	1	1	1	1	1
Qus. 2	1	1	1	1	1	1	1	1
Qus. 3	3	3	3	3	3	1	3	3
Qus. 4	1	1	1	1	1	1	1	1
Qus. 5	3	3	3	3	3	3	3	3
Qus. 6	1	1	1	1	1	2	1	1
Qus. 7	1	2	1	2	2	1	1	1
Qus. 8	3	3	3	3	3	2	3	3
Qus. 9	2	1	1	1	1	1	1	1

outcomes from surgical procedures, and the degree of a problem is typically related to the type of surgery.¹¹⁻¹⁴

Previous research after pulp harvesting from the chin region has shown both temporary and permanent negative pulp sensitivity. In contrast to transient and permanent alterations in pulp sensitivity after autogenous bone grafts are harvested from the body, retromolar, and ramus regions of the posterior mandible.¹³ In comparison to the mandibular retromolar region, a significantly greater frequency of negative pulp sensitivity and loss of tooth life was seen after autogenous bone graft harvesting from the chin region. Thus, it has been proposed that a safety margin of at least 8 mm below the tooth apices and a maximum harvest depth of 4 mm be used to reduce the possibility of changed tooth sensitivity/vitality after autogenous bone graft extraction from the chin area.¹⁵⁻¹⁸

Additional randomized controlled trials evaluating problems and donor site morbidity after autogenous bone graft extraction from the mandibular chin and retromolar regions. One year after autogenous bone graft harvesting from the chin region, a previous study measuring patients' views of changes in facial esthetics,

eating, speaking, and lower lip movement found no change in the preoperative VAS score.¹⁹

Studies found that after autogenous bone graft was harvested from the mandibular retromolar rather than the chin region, patients reported much higher satisfaction, lesser discomfort, and acceptance of the surgical technique.²⁰ Autogenous bone graft harvesting from the ascending mandibular ramus was favored by patients over harvesting from the chin region, according to a recent study that evaluated patient reported outcome measures (PROM) using questionnaires and interviews.^{21,22}

The absence of a standardized terminology, uniform subjective tests, and length of observation period influence the results and conclusions of the present systematic review. Raghoobar et al.¹⁴ in their studies mentioned that bone from the retromolar region was preferred for vertical and horizontal onlay augmentation procedures compared with the chin bone. Sakkas A et al.¹⁵ used several grafting procedures and have described them to create and identify a sufficient volume of bone that is suitable for implant placement. In order to decrease surgery duration and donor site discomfort, autologous bone sources and bone substitutes

from various bone origins such as allografts and xenografts in reconstructive implant surgery have also been used in their study.

Sakkas et al.¹⁵ have reported the final results of the augmentation procedure based on the quality of bone graft and its outcome on implant placement. Both the harvesting and grafting procedures are usually performed in the same surgical field. In the study, seven out of 104 retromolar grafts and one out of 11 symphysis grafts were lost due to postoperative complications. Another study by Nkenke and Neukam²³ and Wushou A et al.²⁴ demonstrated the low graft failure rate and the well acceptance of these methods by the patients.

Scarano et al.²⁵ demonstrated a high number of successfully treated patients with an implant survival rate of 98.0% 4 years after augmentation using biomaterials, 116 bone grafts had to be removed due to infection. Postoperative morbidity after mandibular bone harvesting procedures was also reported in most cases. Misch and Misch¹² studies showed 10.4% of the trabecular pattern of the graft was taken from the mandibular molar region and 2.8% of graft was taken from the symphysis region of the mandible, results were similar to the literature. To determine the quality of the retromolar bone and its resorption in the follow-up evaluation, more histological research is required. This could reduce the amount of early resorption and improve the graft's bone quality.^{9,26,27}

Khoshhal S et al.¹⁶ study explains that the patients were harvested grafts from the mandibular retromolar and chin region. He preferred the convex cross-section of the bone graft which is ideal for the reconstruction of alveolar projection loss in the anterior and posterior maxillary zone. Pikos¹³ in their study reported that complete bone deposition could be detected after 9 months. Likewise, Felice et al.²⁸ demonstrated the presence of a newly formed bone at the donor site after 8 months. However, these evaluations were performed using panoramic radiographs, which were inaccurate owing to their two-dimensional nature and image distortion. Schwartz-Arad et al.²⁹ demonstrated bone formation in mandibular symphysis defects using computed tomography (CT). Similarly, Verdugo F et al.³⁰ attempted to quantify the mandibular symphysis bone formation after bone block harvesting with CT evaluation at different time points. He also delineated in his study about results of study of Diaz-Rodriguez et al.³¹ that was based on performed CT evaluations of the bone formation in the mandibular ramus 6 months after bone harvesting. In this study, pixel value calculation was used to evaluate the quality of the newly generated bone, the study implemented histogram matching also and several factors contributed to the results.

Zhao R et al.,¹⁷ Pommer B et al.,³² and N6ia CF et al.³³ studies mentioned of comparing two grafts from symphysis and retromolar region of mandible and investigated the embryonic origin of the graft (intramembranous bone grafts have minimal resorption compared with endochondral bone grafts), cortical/cancellous ratio and adaptation of the bone grafts to the recipient sites and found half-columnar grafting from the posterior mandible region exhibited better graft stability.

The limitation of the present systematic review includes that the different assessment techniques and different methodological confounding variables presented significant obstacles to a quantitatively comprehensive examination of the literature. Conclusions derived from the systematic review's findings need to be interpreted with caution.

CONCLUSION

The systematic review deduces that the retromolar group has shown better results for ridge augmentation in the maxilla compared with the chin group and the retromolar group produces better and more successful implant placement with less chances of failure compared with the chin group. Regarding the comparison of the stability of the implant, further studies and more implementation of the instrument should be done to get an appropriate result that will determine the stability quantitatively with appropriate values.

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