Received: 14 February 2023 | Revised: 9 June 2023 | Accepted: 10 June 2023

DOI: 10.1111/cid.13242

WILEY

ORIGINAL ARTICLE

Comparison of morbidity-related parameters between autologous and allogeneic bone grafts for alveolar ridge augmentation from patients' perspective—A questionnaire-based cohort study

Diana Heimes[1] | Andreas Pabst[1,2] | Philipp Becker[1,2] | Amely Hartmann[1,3] | Frank Kloss[4] | Jochen Tunkel[5] | Ralf Smeets[6] | Peer W. Kämmerer[1]

[1]Department of Oral and Maxillofacial Surgery, University Medical Center Mainz, Mainz, Germany

[2]Department of Oral and Maxillofacial Surgery, Federal Armed Forces Hospital, Koblenz, Germany

[3]Private Practice for Oral Surgery, Filderstadt, Germany

[4]Private Practice for Oral and Maxillofacial Surgery, Lienz, Austria

[5]Private Practice for Oral Surgery and Periodontology, Bad Oeynhausen, Germany

[6]Department of Oral and Maxillofacial Surgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

Correspondence
Diana Heimes, Department of Oral and Maxillofacial Surgery, University Medical Center Mainz, Augustusplatz 2, 55131 Mainz, Germany.
Email: diana.heimes@unimedizin-mainz.de

Abstract

Introduction: Alveolar ridge augmentation is often required before dental implant placement. In this context, autologous bone grafts are considered the biological gold standard. Still, bone block harvesting is accompanied by some serious potential disadvantages and possible complications, such as pain, bleeding, and nerve irritation. Several studies aimed to compare autologous to allogeneic bone grafts concerning bone quality and implant survival rates; this is the first prospective study analyzing and comparing morbidity-related parameters after alveolar ridge augmentation using autogenous and allogeneic bone blocks from patients' perspective.

Methods: Using a questionnaire, 36 patients were asked to evaluate the surgery as well as the post-operative period concerning pain, stress, sensibility deficits, satisfaction with, and consequences from the surgery as well as the preferred procedure for future alveolar ridge augmentations.

Results: No significant differences were shown regarding stress and pain during and after surgery, whereas the rate of nerve irritations was twice as high in the autologous group. The swelling was significantly higher in patients with autologous bone blocks ($p = 0.001$). Nevertheless, the overall satisfaction of patients of both groups was very high, with over 8/10 points.

Conclusions: The swelling was the main reason for patients' discomfort in both groups and was significantly higher after autologous bone augmentation. Since this side effect seems to be a highly relevant factor for patients' comfort and satisfaction, it needs to be discussed during preoperative consultation to allow shared decision-making considering the anticipated morbidity.

Diana Heimes and Andreas Pabst contributed equally to this study.

KEYWORDS
allografts, alveolar ridge augmentation, autografts, morbidity, pain, patient satisfaction, questionnaire

What is known?

Autologous bone grafts are considered the biological gold standard for alveolar ridge augmentation. However, they are associated with donor side morbidity. Comparisons between autologous and allogeneic grafts regarding bone quality and implant survival show equivalent results.

What this study adds?

This is the second prospective cohort study particularly analyzing the morbidity of autologous to allogeneic bone grafts concerning the patients' perspectives. It suggests higher morbidity and more side effects after autologous bone graftig.

1 | INTRODUCTION

Alveolar ridge augmentation is often required before dental implant placement. The optimal grafting material must have osteoinductive, osteoconductive, and osteogenic characteristics. Furthermore, new bone formation and sufficient long-time stability of the grafted sites must be ensured.[1]

Depending on the defect size and morphology, different options are given. Rather small defects may easily be augmented with particulate graft material of autologous, allogeneic, xenogeneic, or alloplastic origin with or without membrane coverage, namely guided-bone regeneration (GBR); large defects, especially class III and IV defects with horizontal or vertical deficits of more than 3 mm demand for more complex procedures like bone block augmentation or shell technique.[2–5] Nowadays, autologous bone grafts from intraoral donor regions, such as the external oblique line, are regarded as the biological "gold standard" due to their favorable biological characteristics and features. These grafts are well-established and extensively documented in clinical use, and neither immunological reactions nor intolerances are known. Furthermore, they show a high resorbability and a sufficient remodeling capacity.[6–9]

Considering the morbidity and potential complications caused by a secondary harvesting defect and an additional invasive intervention, it must be questioned if autologous bone is still the gold standard. When harvesting cortical bone blocks, for example, for onlay osteoplasty or shell technique, from the external oblique line, a considerably longer operation time may be accompanied by side effects like pain, swelling, and masticatory dysfunction. Furthermore, nerve irritation or damage, especially of the inferior alveolar nerve, is reported in 7% of cases leading to temporary or even permanent numbness of the teeth, lip, and chin, or neuropathy may be causing chronic pain—complications massively affecting patients' comfort, and in worst case scenario, further life.[10–14]

Commercially available alternatives to autologous blocks comprise allogeneic and xenogeneic bone blocks, while blocks of xenogeneic origin show inferior results compared to both, autologous and allogeneic grafts.[5,15] Comparing the latter, autologous grafts show better osseointegration, less resorption, and a low complication rate.[5,16–18] Contrarily, Kloss and colleagues[19] were able to demonstrate homologous results regarding resorption and bone height gained in vertical and lateral augmentation over 1 year after block augmentation. Analogous findings were obtained in several studies showing satisfying results concerning vertical and horizontal bone height after augmentation with allografts accompanied by a low complication rate.[20–23] Comparing autologous and allogeneic cortical bone blocks for shell technique, Tunkel and colleagues showed comparable results regarding vertical and horizontal augmentation gain.[24]

While high long-term success rates are reported for autologous shells filled with autologous bone particles,[25] the evidence on allogeneic shells are scarce and limited to some case series.[26–29] Nevertheless, allogeneic shells could be favorable in preventing donor site morbidity.

Due to the lack of data regarding intraoperative and postoperative discomfort and morbidity-related parameters experienced by patients, this questionnaire-based study aimed to assess patients' perception of surgery-related side effects and comfort after either alveolar ridge augmentation with an allogeneic or an autologous bone block harvested from the retromolar region.

2 | MATERIALS AND METHODS

In total, 36 patients treated at the Department of Oral and Maxillofacial Surgery of the University Medical Center Mainz (Germany), the Federal Armed Forces Hospital (Germany), the Private Practice for Oral and Maxillofacial Surgery in Lienz (Austria), and the Private Practice for Oral Surgery and Periodontology in Bad Oeynhausen (Germany) over a 12-month period were included within this prospective observational study after approval of the local ethics committee (Nr. 2018-13 776-Epidemiologie). The study was registered prospectively in the German Registry of Clinical Studies (DRKS00027341).

Patients were informed about the study during consultation and planning of the dentoalveolar treatment. If interested, a detailed explanation was given; information about the study was handed out

in written form, and informed consent was obtained. All patients were equally informed about the postoperative behavior, such as physical rest and soft diet. Four surgeons performed the operations (JT, FK, AP, and PWK), explained the study to the patients, and handed the forms. The surgeons were not calibrated; examinations were unnecessary since the patients filled out the questionnaire.

2.1 | Inclusion and exclusion criteria

Adult patients who were treated at one of the aforementioned departments and private practices who were planning to get either an autologous or an allogeneic bone block for alveolar ridge augmentation were included in the study. During the appointment, a detailed explanation was given about the procedures' advantages, disadvantages, possibilities, and limitations. A decision was made with the patient (shared decision-making) for the procedure of choice. Subsequently, the patients were asked whether they would like to participate in the study, and if they agreed, they were informed about the study. Exclusion criteria were age under 18 years, mental disability, pre-existing chronic pain (especially in the head and neck region), patients taking bisphosphonates or being radiated in the head and neck region, patients with acute or chronic infections within the mouth as well as refusal to participate in the study. Only augmentations of the mandible were included.

Defects treated within this study were class 3/4 and 4/4 defects.[2]

2.2 | Study design

The study was designed as an observational multicentric questionnaire-based trial. All procedures were performed according to hygienic and surgical standards by experienced oral and maxillofacial surgeons and oral surgeons. Before the surgical procedure, the questionnaire was handed out to the patients, potential questions were discussed, and they were asked to return after completion. The time frame for filling out the questionnaire was 10 days after surgery (time of removal of the sutures). By that, we intended to check postoperative morbidity only by excluding the potential influence of sedation procedures. Before the study, internal and external questionnaire evaluation was performed according to international guidelines. The validation sample data were collected between 2021 and 2022 as a part of baseline data. First, the questionnaire was validated by an expert group consisting of oral and maxillofacial surgeons and specifically trained personnel for assessing patient-reported outcomes ($n = 5$ each). After expert validation, an independent sample representing the dissimilar target population was consulted. Face and construct validity were guaranteed.

Since no comparable study has been published yet, calibration and statistical validation were impossible. Furthermore, the independence of each question and the respective analysis limits the risk of systemic error, which is involved in complex questionnaires evaluating higher constructs.

2.3 | Surgery

The surgery was performed under local anesthesia with light intravenous sedation reflecting the clinical practice of the involved centers. Depending on the defect size and morphology, a crestal incision with trapezium-shaped or marginal relieving incisions was performed in the defect region to raise a full-thickness mucoperiosteal flap. The underlying bone was cleaned from the connective tissue residues and measured by a sterile caliper to estimate the defect size and bone needed for augmentation. Since all defects could have been augmented with both allogeneic material and a block from the external oblique line of the mandible only, the defect size was limited (as stated above, class 3/4 and 4/4 defects according to the Terheyden classification).

Postoperatively, all patients received oral antibiotics (amoxicillin and clavulanic acid 875/125 mg) preoperatively and for 7 days after surgery. Analgesia was provided with ibuprofen 600 mg up to four times a day for a maximum of 2 days, and patients were also instructed to rinse with chlorhexidine-digluconate thrice daily.

2.4 | Autologous bone graft

Autologous bone blocks and shells were harvested from the external oblique line of the mandible as already described by Khoury and Hanser[13] In short, a trapezius-like incision was made, followed by subperiosteal preparation. Depending on the defect size, the tissue available at the donor site and the bone quality needed for augmentation were harvested using a microsaw or piezosurgery. The harvested bone blocks were split into two pieces for the shell technique or left in their continuity to allow augmentation with a bone block as onlay osteoplasty. The further procedure was the same as for augmentation with an allogeneic block.

2.5 | Allogeneic bone graft

In case of allogeneic bone block and cortical plate insertion, the bone was adjusted to the defect size, and sharp edges were smoothened. Cortical plates (maxgraft® cortico, botiss biomaterials GmbH, Zossen, Germany) were rehydrated with 0.9% saline at room temperature for at least 10–20 min to increase the breaking strength and flexibility as described elsewhere.[30] At least two microscrews were used to fixate the shell buccally and/or orally. The cavity was filled with either autogenous or allogenous granules or a mixture of allogeneic and autologous particles harvested from the augmentation site using a bone scraper. Mobilization of the mouth floor was performed, and a periosteal incision was made in the buccal region of the lower jaw to allow tension-free closure of the augmented area (protocol described earlier by Tunkel and colleagues[24]). In case of bone block insertion, the bone was adjusted to the defect size and sharp edges were smoothened. Allogeneic bone blocks were fixed with at least two microscrews as well. While adjusting screws were used for the shell

technique, blocks used lag screws. Using blocks, special attention was spent on a perfect fit of the blocks on the defect region.

2.6 | Statistics

A sample size calculation was performed. To achieve a study power of at least 90%, 16 patients were required in each of the two experimental groups. In 2016, Aslan and colleagues[31] reported a pain intensity after allogeneic bone block insertion of 2.5 on the third postoperative day (visual analog scale (VAS) = 0–10), while no pain was reported by the seventh postoperative day. In contrast, Nkenke and colleagues[32] analyzed the degree of morbidity after harvesting oral bone blocks for alveolar ridge augmentation and found that the average pain intensity (converted from a 0–100 VAS to a 0–10 VAS) was 6.4. Based on these data, the sample size calculation was performed using a slightly smaller difference in VAS between the groups (3 vs. 6 points on the VAS).

$$\text{Cohen's } d = \frac{M_1 - M_2}{\text{SD}} = \frac{6-3}{2.5} = 1.2$$

According to Ryan and colleagues "Sample Size Determination and Power. Wiley Series in Probability and Statistics" the following results:

$$N = 2 * \frac{\left(z_{1-\alpha/2} + z_{1-\beta}\right)}{\left(\frac{\delta}{\sigma}\right)^2}$$

With an effect size of $d = 1.2$ and a power of 0.9, it would take 16 subjects per group (32 total) to achieve significant results with a two-sided unpaired t-test ($\alpha = 0.05$).

These calculations are also consistent with the sample size calculations of other studies that assessed the morbidity after bone block harvest or augmentation (Nkenke and colleagues 2001 [20 patients] and Krasny and colleagues 2015 [21 patients]), whereas a similar study aiming to analyze pain included even fewer patients per group (Hartlev and colleagues 2020 [14 patients]).

The questionnaire used in this study is found in Table 1.

Statistics were performed using IBM SPSS Statistics for Macintosh, version 27 (Armonk, NY, USA, IBM Corp). To analyze the differences between the measured values, normality (Kolmogorov–Smirnov) and homogeneity of variance tests (Levene statistic) were performed at first in order to check the conditions for the subsequent analysis. The p-values were obtained with an independent samples t-test. A p-value <0.05 was termed significant.

3 | RESULTS

A total of 36 patients were treated with either allogeneic ($n = 20$) or autologous ($n = 16$) bone grafts for alveolar ridge augmentation. Neither patient suffered from systemic diseases, smoked, or met the exclusion criteria, which could potentially affect the surgery's outcome. Eleven women and nine men were assigned to the allogeneic group, and nine women and seven men to the autologous group (mean 42 years; SD = 5.3 years). In the initial healing phase of 10 days observed in this study, there was one delayed wound healing in the allogeneic and one in the autologous group. Though, no further intervention was needed. No patient reported an additional need for analgesics exceeding the recommended amount.

3.1 | Stress

The patients were asked to evaluate the stress caused by the surgery within the first 3 days after surgery and in general. Patients receiving allogeneic bone for ridge augmentation showed a mean stress level (VAS = 1–10) of 3.30 ± 2.34 within the first 3 days and an overall stress level of 3.40 ± 2.62, whereas the pain level was 4.44 ± 2.76 in patients receiving an autologous block for augmentation after 3 days and 3.80 ± 2.54 in general ($p > 0.05$; Figure 1).

3.2 | Pain

Furthermore, patients were asked if they experienced pain during the surgery and within the first 3 days after surgery. If yes, they had to evaluate the pain strength using a VAS ranging from 1 (low pain level) to 10 (highest pain level conceivable). Three patients in the allogeneic group stated to perceive pain during the surgery and rated the pain level at 5.67 ± 1.86. Taken together with the patients not perceiving any pain (VAS = 0), the pain level was 0.85 ± 0.52 on average. A total of nine patients reported of pain within the first 3 days after surgery with a mean pain level of 5.22 ± 0.88 (2.35 ± 0.71 overall). Two patients within the group receiving autologous grafts reported of pain during the surgery with a mean strength of 5.50 ± 0.5 (0.69 ± 0.47). Within the first 3 days after surgery, eight patients reported of pain with a strength of 5.00 ± 0.76 (2.5 ± 0.74 overall; $p > 0.05$ each). The mean duration of pain perceived after surgery was 3.44 ± 1.42 within the allogeneic group and 3.38 ± 2.00 within the autologous group without significant differences ($p > 0.05$; Figures 2 and 3).

3.3 | Discomfort

If the bone block was harvested from the external oblique line, patients were asked to state, if bone block harvesting or the insertion was more unpleasant and if they noticed the second wound originating from bone block removal. Furthermore, they were asked to evaluate the discomfort originating from the second surgical wound. Seven patients perceived the block harvesting and one patient the block insertion to be more unpleasant. Nine/fifteen patients noticed the second wound originating from block harvesting and 3/11 found the wound to be discomfortable (Table 2).

TABLE 1 Questionnaire.

Class	Question	Answer
Distress	How distressing did you perceive the first 1–3 days after surgery?	VAS 0–10
	Overall, how distressing did you perceive the surgery to be?	VAS 0–10
Pain	Did you experience any pain during the surgery?	Yes/No
	If so, how severe was this pain?	VAS 0–10
	Did you experience pain during the first 1–3 days after surgery?	Yes/No
	If so, how severe was this pain?	VAS 0–10
	If so, for how many days after surgery did you experience pain?	Ordinal (days)
Discomfort	If the bone used was harvested from your jaw: Did you find the removal of the bone or the insertion into the bone defect more unpleasant?	Categorial (harvest/insertion)
	If the bone used was harvested from your jaw: Did you notice the second surgical wound (wound of the bone removal) in your mouth after the surgery?	Yes/No
	If yes, did you experience any discomfort from this second surgical wound?	Yes/No
Nerve injury	Did you feel any numbness of the tongue, lower lip, or cheek in the first 1–3 days after surgery?	Yes/No
	If so, how distressing did you perceive this numbness to be?	VAS 0–10
	If so, how long did this numbness last?	Ordinal (days)
Swelling	How much swelling did you experience after surgery?	VAS 0–10
	How stressful did you consider the swelling after the surgery?	VAS 0–10
Satisfaction	Would you have the procedure performed on you again?	Yes/No
	Case no, why not?	Free text
	Would you recommend the procedure to your relatives and friends?	Yes/No
	Case no, why not?	Free text
	Overall, did the procedure meet your expectations?	Yes/No
	Case no, why not?	Free text
Medical condition	How many days after the procedure were you completely free of symptoms?	Ordinal (days)
	Which symptoms were the worst for you after the surgery?	Free text
	For you, what was the most discomforting part of the entire treatment?	Free text
	How satisfied are you with the treatment overall?	VAS 0–10
Postoperative choice	Would you have any concerns about the use of the bone or bone substitute materials listed below if they were to be used in your mouth or jaw: (a) Bone from yourself (e.g., taken from your own lower jaw).	Yes/No
	Case yes, why?	Free text
	Would you have any concerns about the use of the bone or bone substitute materials listed below if they were to be used in your mouth or jaw: (b) Bone donated by another person (taken from a living or deceased donor)	Yes/No
	Case yes, why?	Free text
	Would you have any concerns about the use of the bone or bone substitute materials listed below if they were to be used in your mouth or jaw: (c) bovine bone (taken from a deceased bovine animal)	Yes/No
	Case yes, why?	Free text
	Would you have any concerns about the use of the bone or bone substitute materials listed below if they were to be used in your mouth or jaw: (d) Artificial bone (bone made exclusively from artificial/synthetic materials).	Yes/No
	Case yes, why?	Free text

Abbreviation: VAS, visual analog scale.

3.4 | Nerve injury

Being asked for any numbness of the tongue, lip, or cheek, two patients in the allogeneic group and five patients within the autologous group confirmed numbness after surgery. The patients reported of a distress level of 4.40 ± 2.97 (VAS = 1–10) within the autologous and of 2.50 ± 0.71 within the allogeneic group. The mean duration of numbness of patients receiving an allogenous bone block

was 4 days and 4.40 ± 2.30 days of patients receiving an autologous bone block for alveolar ridge augmentation ($p > 0.05$ each; Figure 4).

3.5 | Swelling

Patients were further asked for swelling experienced after surgery as well as the discomfort originating from this side effect. Using a VAS, patients being assigned to the allogeneic group reported of a mean level of swelling of 3.60 ± 2.21 and a mean discomfort of 2.79 ± 1.84. The severity of swelling was reported to be 6.25 ± 2.21 ($p = 0.001$) and the discomfort originating from this to be 4.60 ± 2.17 within the autologous group ($p = 0.013$; Figure 5).

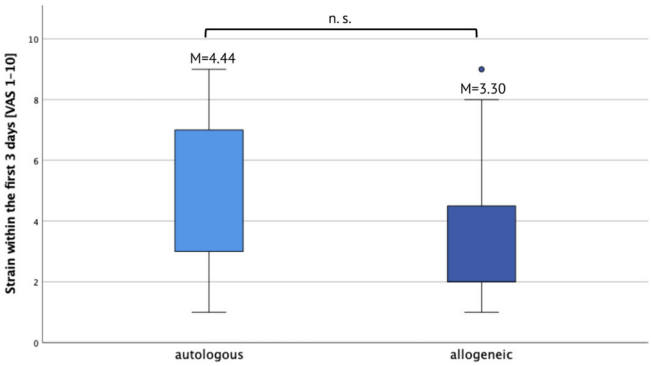

FIGURE 1 Stress within the first 3 days after surgery. M, mean value; ns, nonsignificant; VAS, visual analog scale.

3.6 | Satisfaction

The patients were asked to answer if they would have the surgery performed again, if they would recommend this procedure to their relatives and if the operation met their expectations. One hundred percent of patients receiving an allogeneic bone block would repeat the procedure for alveolar ridge augmentation, 20/20 patients would recommend the surgery to their relatives and 19/20 patients stated that the surgery met their expectations. After autologous bone block augmentation, 87.5% patients stated, that they would have the surgery performed again and 14/15 patients to recommend the procedure to their relatives. A total of 12/16 patients stated that the procedure met their expectations (Table 3).

3.7 | Medical condition

Being asked after how many days the patients were free of symptoms, which symptoms were worst after surgery and what was the

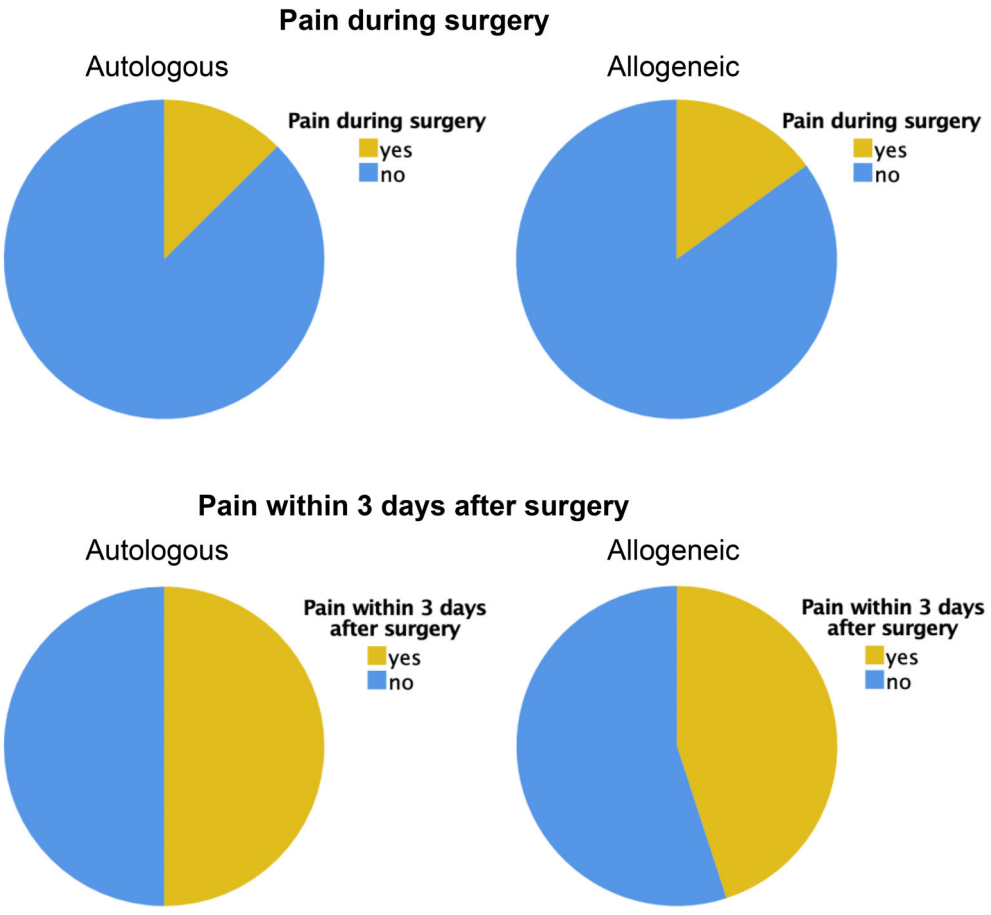

FIGURE 2 Number of patients perceiving pain during surgery and number of patients perceiving pain within 3 days after surgery.

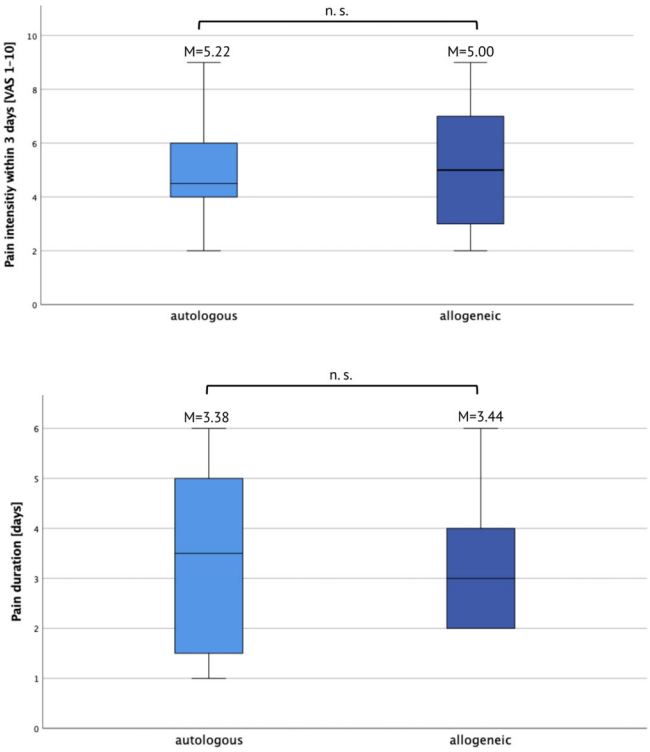

FIGURE 3 Pain intensity within 3 days after surgery and duration of pain perceived after surgery. M, mean value; ns, nonsignificant; VAS, visual analog scale.

most discomforting part of the whole procedure, patients being treated with allogeneic blocks were free of symptoms after a mean of 3.89 ± 2.22 days. They found the swelling to be the worst part after surgery, followed by pain and masticatory dysfunction. Discomfort overall was reported to be perceived due to pain, the local anesthesia, the duration of the surgery and the sutures. On the other hand, patients receiving an autologous bone block reported of being free of symptoms after 5.19 ± 1.56 days on average ($p = 0.048$). The swelling was reported to be the worst part after the surgery followed by pain and hematoma. Local anesthesia, pain, and swelling were reported to be the most discomforting part overall (Figures 6 and 7).

3.8 | Overall satisfaction

Patients receiving allogeneic bone block grafts rated their satisfaction with the treatment (VAS = 1–10 with 1 meaning totally unsatisfied and 10 totally being satisfied) at 9.40 ± 1.79 on average and the autologous group at 8.56 ± 2.63 ($p > 0.05$; Figure 8).

3.9 | Postoperative choice

Postoperatively, patients were asked if they would have any concerns regarding the use of bone or bone substitute materials if it was to be used in their mouth or jaw. The question referred to the use of (a) autologous, (b) allogeneic, (c) xenogeneic, and (d) alloplastic material/artificial bone. Ten patients of the allogeneic group stated to have concerns if autologous bone was used in their jaw. Concerns regarding this material was mostly explained by the morbidity expected by the patients. Of those patients, no one stated concerns if allogeneic, one if xenogeneic (due to better alternatives) and two if alloplastic material (due to better alternatives) would be used in their mouth. Three patients receiving autologous bone blocks stated concerns regarding the use of this material due to the morbidity associated with the surgery; a total of six patients stated concerns regarding the use of allogeneic (due to the idea of less tissue integration compared to autologous material, the feeling of receiving material from donors to be morbid/unnatural and a lack of trust to the scientific evidence), five of xenogeneic (psychological problems with the foreign/animal material and fear to get an infection), and three of alloplastic material (due to the fear of less tissue integration).

A summary of all results can be found under Supporting Information (Table S1).

TABLE 2 Number of patients receiving autologous bone blocks for alveolar ridge augmentation (a) reporting of more discomfort due to either block harvesting or insertion, (b) perceiving the harvesting area as second surgical area at all, and (c) feeling discomfort die to the second surgical wound.

If the bone used was harvested from your jaw: Did you find the removal of the bone or the insertion into the bone defect more unpleasant?	Harvesting: 7 patients Insertion: 1 patient
If the bone used was harvested from your jaw: Did you notice the second surgical wound (wound of the bone removal) in your mouth after the surgery?	9/15 patients
If yes, did you experience any discomfort from this second surgical wound?	3/11 patients

4 | DISCUSSION

Patients' desire for fixed prostheses in partially or fully edentulous situations can often only be met using implant-supported prostheses. However, bone supply must be sufficient even with short or diameter-reduced dental implants. The most common reason for an insufficient initial osseous situation, however, is the physiological atrophy of the alveolar ridge and the entire jawbone after tooth loss, which amounts to ~25% of the original bone volume in the first year after tooth loss and ~40%–60% within the first 5 years.[33,34] So far, autologous bone has been referred to the biological gold standard because it possesses all the properties of an optimal material for bone augmentation. However, these advantages are also offset by some limitations and disadvantages of autologous bone, which are primarily related to harvesting

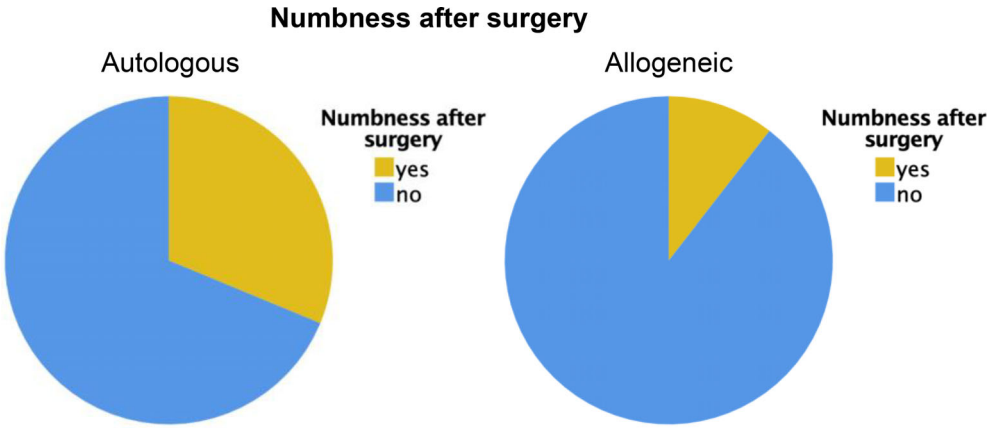

FIGURE 4 Number of patients feeling numbness of the tongue, lip, or cheek.

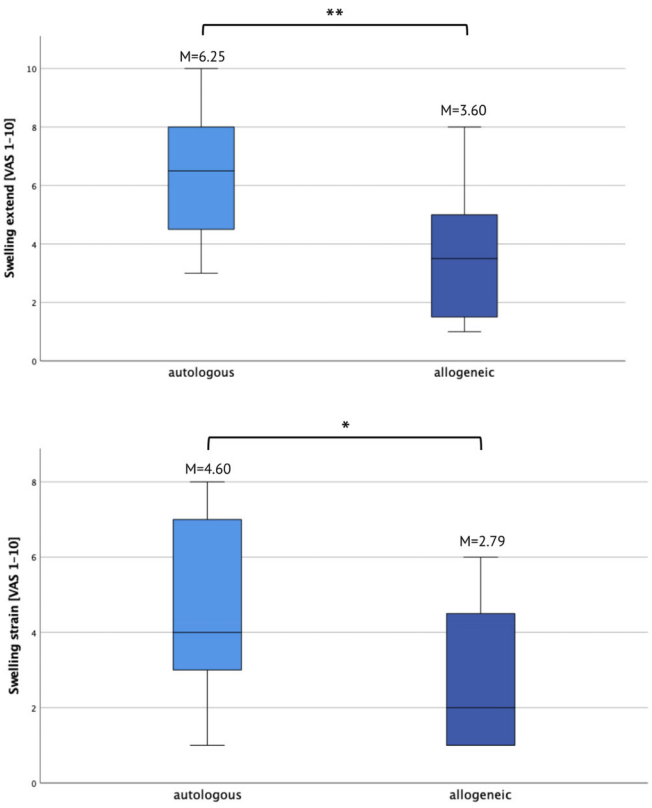

FIGURE 5 (a) Extend of and (b) discomfort due to postoperative swelling. M, mean value; VAS, visual analog scale.

TABLE 3 Number of patients stating (a) to would repeat the procedure, (b) to recommend this surgery to their family and friends, and (c) that the procedure met their expectations.

Would you have the procedure performed on you again?	14/16	20/20
Would you recommend the procedure to your relatives and friends?	14/15	20/20
Overall, did the procedure meet your expectations?	12/16	19/20

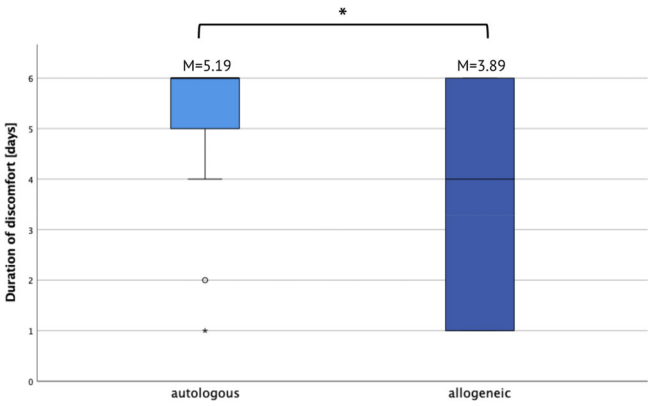

FIGURE 6 Duration of discomfort after surgery. M, mean value.

morbidity. This has led to the development and widespread use of osseous grafts of other origins. Among these, allogeneic bone blocks and shells enjoy the greatest popularity and simultaneously show the most promising results.

Draenert and colleagues suggested classifying complex bone augmentations into (I) osteotomy techniques (sandwich and bone split), (II) distraction osteogenesis, (III) particulate techniques (GBR), and (IV) block techniques (block and lamellae).[35] While most studies aim to clinically compare autologous and allogeneic bone blocks for alveolar ridge augmentation, there has been a lack regarding the patient's perspective of these procedures.

Thus, this study aimed to compare morbidity-related parameters using allogeneic and autologous bone blocks for alveolar ridge augmentation from patients' perspective.

Within this study, no statistically significant difference could be shown regarding stress due to and over 3 days after surgery, whereas the group receiving an autologous bone graft suffered more stress (1 point on VAS on average) than the allogeneic group. Interestingly, no difference in pain perception during and 3 days after surgery could be found. Furthermore, the duration of pain was similar between the groups. More than half of the patients having been augmented with autologous bone blocks noticed the second wound, and most patients

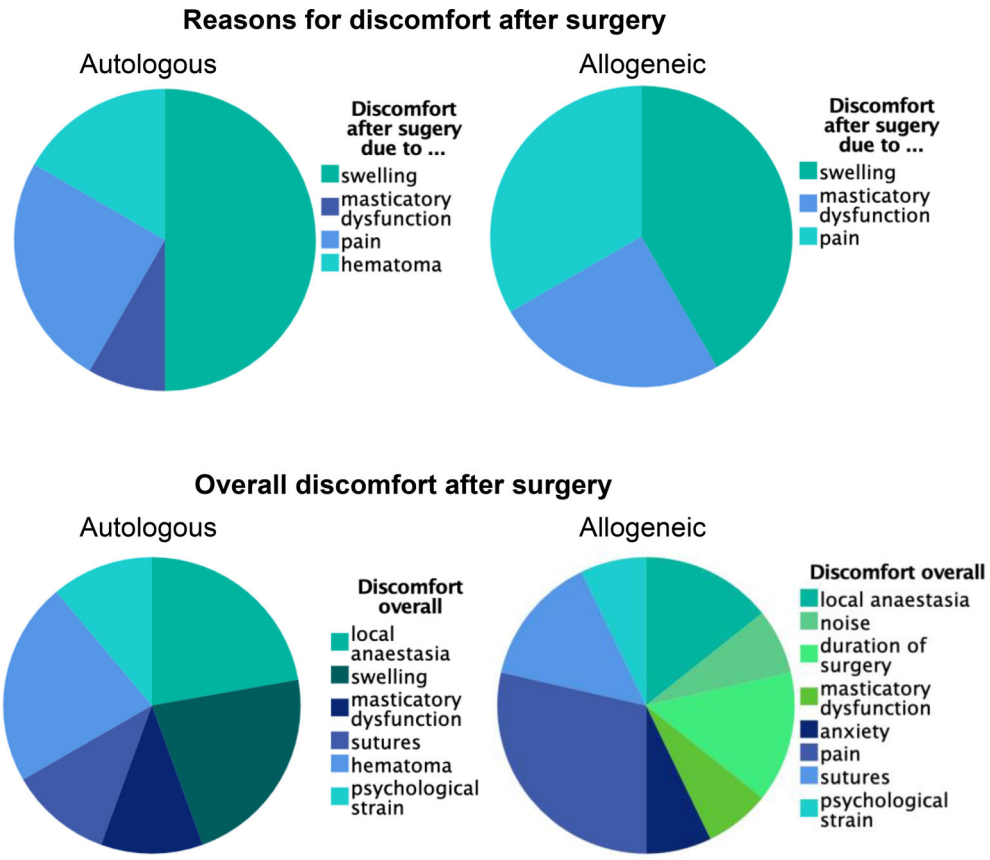

FIGURE 7 Reasons for discomfort after surgery and overall-discomfort.

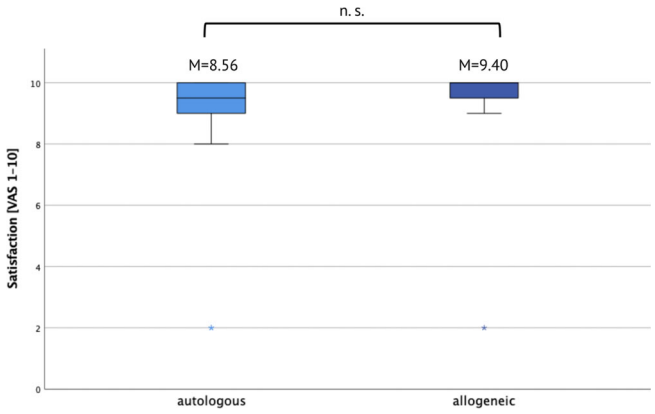

FIGURE 8 Satisfaction of patients with either autologous or allogeneic bone augmentation. M, mean value; ns, nonsignificant; VAS, visual analog scale.

found the harvesting to be more uncomfortable than the insertion. The rate of nerve irritations due to surgery was twice as high in the autologous group compared to the patients receiving allogeneic bone blocks, and the strain rated higher. In contrast, the duration of sensory disturbances did not differ (4 days on average). With three points difference in the VAS, swelling and discomfort due to swelling were significantly higher in patients with autologous bone blocks. The swelling was perceived as the main reason for discomfort in both groups and therefore seemed to be a highly relevant factor for patients' comfort and satisfaction. Besides, patients with autologous bone grafts described feeling discomfort on average 1.5 days longer than patients receiving allogeneic bone grafts. Nevertheless, the overall satisfaction of patients of both groups was very high, with over 8/10 points on the VAS. Interestingly, patients having been augmented with allogeneic bone blocks expressed little concerns regarding the use of augmentation material of allogeneic, xenogeneic and alloplastic material, whereas the major concern against the use of autologous bone was the morbidity associated with the second surgery. Contrarily, most patients receiving autologous bone stated no concerns regarding the use of this material, whereas the major objection against foreign material were the idea of less tissue integration compared to autologous material and the feeling of receiving material from donors to be morbid/unnatural. Here it can be concluded that positive experiences with a surgical method and a certain material raised the chance of choosing this material again, whereas patients in the allogeneic group mostly raised concerns using autologous bone due to the morbidity expected from the block harvesting and the autologous group to raise concerns using other than autologous material due to the idea of a worse tissue integration compared to autologous material.

Given that the procedure aims to allow the insertion of dental implants for oral rehabilitation, the question of the implants' prognosis in the augmented material naturally arises. The choice of material for each individual case is controversial; the effect of different materials on implant survival as one of the most important outcome parameters is still not fully understood. Danesh-Sani and colleagues reached high survival rates even with <30% vital bone within the sinus.[36] In a systematic review, Motamedian and

colleagues aimed to compare implant survival in sites augmented with either allogeneic or autologous bone grafts; due to the heterogeneity of the population no results could be drawn to that effect. The authors observed the morbidity associated with bone harvesting as major in autologous bone grafts and the delayed tissue integration in allogeneic blocks. Implants inserted in sites augmented with autologous bone showed 74%–100% survival rates, and implants inserted in allogeneic bone blocks of 94%–100%.[21] In a clinical study analyzing 67 patients being either augmented with autologous or allogeneic grafts, Schlee and colleagues demonstrated no differences regarding aesthetics between the groups.[37] Pérez-González and colleagues conducted a systematic review and included studies on 234 patients treated with allogeneic bone blocks. The meta-analysis showed an overall survival rate of 94.52% and implant-related survival of 97.36% (follow-up time > 12 months). Complications reported within the included studies were block exposure and failure of osseointegration.[38]

While no differences could be found regarding new bone formation, allogeneic bone blocks show significantly more residual graft than autologous bone (28.9% vs. 19.5%).[39] A systematic review aiming to compare the implant treatment outcome after horizontal ridge augmentation with allogeneic compared to autologous bone blocks found similar survival rates within the two groups. After analyzing complications occurring after horizontal ridge augmentation with allogeneic bone blocks, the included studies showed high frequencies of dehiscence, graft exposure, and partial and total loss of the block—no comparison was made between allogeneic and autologous grafts.[40] Biologic complications similar to those have also been described for autologous bone blocks in a systematic review performed by Aloy-Prósper and colleagues.[41]

Temporary and permanent paresthesia have been described after harvesting autologous bone grafts.[42–44] Here, neurosensory disturbances are seen to appear most often in autologous chin bone blocks,[45–47] which might also lead to aesthetic changes in the facial contour.[46] In a prospective nonrandomized intervention study, 23 patients who received autologous bone grafts from intraoral or extraoral donor sites were asked to complete a questionnaire regarding pain location, intensity, and experience before surgery, 3 days, and 4 weeks after surgery. The authors report pain perceived in both groups. Still, the extraoral group showed to have additional pain at the hip, felt the pain longer and of higher intensity, and had more negative pain experiences compared to the intraoral group.[48] In another study, permanent sensory disturbances were reported in 13.5% of cases in which bone blocks were taken from the mandibular symphysis; one out of 43 patients exhibited paresthesia after block harvesting from the retromolar area, whereby the authors reported a higher frequency of bleeding events compared to the symphysis group.[7] Within our study, a higher frequency (31.25%) of temporary sensory disturbances was observed that lasted for less than a week.

In a comparative clinical study, Iancu and colleagues analyzed immediate postoperative complications after lateral ridge augmentation using either the shell technique or sticky bone. They found a higher pain level in the shell group (mostly mild to moderate pain); interestingly, the pain intensity could be associated with the harvesting method: higher pain levels were observed in patients where the bone block was harvested using a diamond disk compared to using piezosurgery. Trismus, temporary neurosensory disturbances, and severe hematomas needing drainage, as further side-effects of bone harvesting procedures were reported to be more severe after bone block harvesting for shell technique. No differences were observed regarding dehiscence and post-operative bleeding.[49] Kloss, Kämmerer, and colleagues analyzed 221 cases of alveolar ridge augmentation using autogenous or allogeneic bone. They reported a higher complication rate with autogenous (20%) compared to allogeneic bone blocks (7.9%) and identified smoking and vertical augmentation above a threshold of 2.55 mm (OR = 5.0), and over-contouring (OR = 15.3) as risk factors. No significant differences were observed in the frequencies of wound dehiscence, infection, implant loss, and total loss of the bone block.[29]

Bearing in mind those very complications, the use of allogeneic bone blocks seems reasonable, offering several advantages over autologous grafts: unlimited availability, a considerably shorter surgery time, as well as lower morbidity, especially regarding neurosensory disturbances and swelling events. Using allogeneic bone blocks facilitates presurgical planning; it is possible to fabricate customized bone blocks adapted to the patient's needs.[50] The osseointegration rate seems comparable to autologous bone blocks.[38] In contrast, resorption rates are hardly comparable due to the heterogeneity of the material used as allogeneic graft.

Hof and colleagues conducted a questionnaire-based study on 150 patients, asking for their perspectives on dental implant and bone graft surgery. Sixty-one percent were willing to undergo bone graft surgery, most favoring harvest from the retromolar area over the hip. Only 43% opted for bone substitute material to avoid donor site morbidity, and more than two-thirds were willing to accept additional costs from three-dimensional planning to avoid bone augmentation. Therefore, it can be concluded that—before bone augmentation—the acceptance of such procedures is high, whereas minimally invasive procedures are favored over alternatives.[51] Here, our study showed similar results with a high satisfaction rate, and most patients of either group recommended the augmentation procedure to their relatives and friends.

In 2023, the first pilot study was published to analyze patient-centered outcomes after autogenous and allogenic bone blocks in the augmentation of deficient alveolar ridges. Analogous to previous studies, they reported more bone gained during augmentation using autografts, whereas patient-reported experience and outcome measures revealed better patient satisfaction in the allogeneic group. However, it has to be admitted that the quality of the study seems to be rather low; neither the citation nor the cross-reference to the figure matches the information given in the text: the study does not give any information on the questionnaire used; therefore, the quality of the outcome parameters may be questioned.[52]

Shortcomings of the present study are the rather small number of patients included and the questionnaire-based character. Especially, the lack of calibration and statistical validation due to

the study's explorative nature may limit the data quality. But, since each question is discrete, the risk of bias is not comparable to complex questionnaires evaluating higher constructs, which can be considered an advantage in this study. Further features influencing the outcome could have been the surgery performed by (a small number of) different surgeons, the induvial surgical technique, and the postoperative medication. It must also be admitted that compliance with the postoperative regimen can never be ensured. Furthermore, it must be admitted that the character of the preoperative information may affect patients' opinions on different augmentation procedures and the anticipated risks. What is more, minimal sedation might have affected the study's outcome. But since it was used in both groups, bias could be ruled out.

5 | CONCLUSION

To the author's best knowledge, this is the second study analyzing morbidity-related parameters after augmentation procedures with either allogeneic or autologous bone blocks from patients' perspectives. Given the theory that long-term outcomes and implant survival rates are similar between the two groups, the complication rate and patients' procedure experience are relevant factors that should be considered when choosing graft materials. Based on this data, a shared decision must be made with the patient regarding which material he or she prefers. The information gained by this study may help to choose the best technique and material for each patient and facilitate shared decision-making.

AUTHOR CONTRIBUTIONS

Concept/design: Andreas Pabst, Frank Kloss, Jochen Tunkel, Ralf Smeets, and Peer W. Kämmerer. *Data analysis/interpretation*: Diana Heimes, Andreas Pabst, Philipp Becker, Amely Hartmann, Frank Kloss, Jochen Tunkel, Ralf Smeets, and Peer W. Kämmerer. *Drafting article*: Diana Heimes, Andreas Pabst, and Peer W. Kämmerer. *Critical revision of article*: Diana Heimes, Andreas Pabst, Philipp Becker, Amely Hartmann, Frank Kloss, Jochen Tunkel, Ralf Smeets, and Peer W. Kämmerer. *Approval of article*: Diana Heimes, Andreas Pabst, Philipp Becker, Amely Hartmann, Frank Kloss, Jochen Tunkel, Ralf Smeets, and Peer W. Kämmerer. *Statistics*: Diana Heimes. *Data collection*: Andreas Pabst, Philipp Becker, Amely Hartmann, Frank Kloss, Jochen Tunkel, and Peer W. Kämmerer.

ACKNOWLEDGMENT

Open Access funding enabled and organized by Projekt DEAL.

FUNDING INFORMATION

This research received no external funding.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest. Andreas Pabst, Frank Kloss, Jochen Tunkel, Ralf Smeets, and Peer W. Kämmerer received speaker fees and research support from Straumann AG (Basel, Switzerland) and from botiss biomaterials GmbH (Zossen, Germany).

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analyzed used in this manuscript are available from the corresponding author on reasonable request.

ETHICS STATEMENT

The study was conducted in accordance with the declaration of Helsinki, and approved by the ethics committee of the federal state of Rhineland-Palatinate (Protocol code 2018–13776, 10/26/2021).

ORCID

Diana Heimes https://orcid.org/0000-0001-9899-7715
Andreas Pabst https://orcid.org/0000-0003-4841-7203
Amely Hartmann https://orcid.org/0000-0001-5934-3671
Frank Kloss https://orcid.org/0000-0001-6748-6365
Jochen Tunkel https://orcid.org/0000-0002-6599-1146
Ralf Smeets https://orcid.org/0000-0002-0207-5474
Peer W. Kämmerer https://orcid.org/0000-0002-1671-3764

REFERENCES

1. Kämmerer PW, Buttchereit I, Pabst A. Allogeneer Knochen–Knochenersatzmaterialien oder Ersatz für autologe Transplantate? *Quintessenz J*. 2017;12:1377-1385.
2. Terheyden H. Knochenaugmentationen in der Implantologie. *Dtsch Zahnärztl Zeitung*. 2010;6:320-330.
3. Cordaro L, Terheyden H, Wismeijer D, Chen ST, Buser D. *ITI treatment guide: A staged approach. International Team for Oral Implantology. ICC, ed*. Quintessence Publishing Co; 2014.
4. Titsinides S, Agrogiannis G, Karatzas T. Bone grafting materials in dentoalveolar reconstruction: a comprehensive review. *Jpn Dent Sci Rev*. 2019;55(1):26-32. doi:10.1016/j.jdsr.2018.09.003
5. Troeltzsch M, Troeltzsch M, Kauffmann P, et al. Clinical efficacy of grafting materials in alveolar ridge augmentation: a systematic review. *J Craniomaxillofac Surg*. 2016;44(10):1618-1629. doi:10.1016/j.jcms.2016.07.028
6. Bauer TW, Muschler GF. Bone graft materials. An Overview of the Basic Science. *Clin Orthop Relat Res*. 2000;371:10-27.
7. Fretwurst T, Gad LM, Nelson K, Schmelzeisen R. Dentoalveolar reconstruction: modern approaches. *Curr Opin Otolaryngol Head Neck Surg*. 2015;23(4):316-322. doi:10.1097/MOO.0000000000000167
8. 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. doi:10.1186/s40729-017-0084-4
9. Khan SN, Cammisa FP Jr, Sandhu HS, Diwan AD, Girardi FP, Lane JM. The biology of bone grafting. *J Am Acad Orthop Surg*. 2005;13(1):77-86.
10. Chiapasco M, Zaniboni M, Rimondini L. Autogenous onlay bone grafts vs. alveolar distraction osteogenesis for the correction of vertically deficient edentulous ridges: a 2-4-year prospective study on humans. *Clin Oral Implants Res*. 2007;18(4):432-440. doi:10.1111/j.1600-0501.2007.01351.x
11. Dahlin C, Johansson A. Iliac crest autogenous bone graft versus alloplastic graft and guided bone regeneration in the reconstruction of

atrophic maxillae: a 5-year retrospective study on cost-effectiveness and clinical outcome. *Clin Implant Dent Relat Res*. 2011;13(4):305-310. doi:10.1111/j.1708-8208.2009.00221.x
12. Felice P, Marchetti C, Piattelli A, et al. Vertical ridge augmentation of the atrophic posterior mandible with interpositional block grafts: bone from the iliac crest versus bovine anorganic bone. *Eur J Oral Implantol*. 2008;1(3):183-198.
13. Khoury F, Hanser T. Mandibular bone block harvesting from the retromolar region: a 10-year prospective clinical study. *Int J Oral Maxillofac Implants*. 2015;30(3):688-697. doi:10.11607/jomi.4117
14. Nkenke E, Neukam FW. Autogenous bone harvesting and grafting in advanced jaw resorption: morbidity, resorption and implant survival. *Eur J Oral Implantol*. 2014;7(Suppl 2):S203-S217.
15. Rasch A, Naujokat H, Wang F, Seekamp A, Fuchs S, Kluter T. Evaluation of bone allograft processing methods: impact on decellularization efficacy, biocompatibility and mesenchymal stem cell functionality. *PLoS One*. 2019;14(6):e0218404. doi:10.1371/journal.pone.0218404
16. Lumetti S, Galli C, Manfredi E, et al. Correlation between density and resorption of fresh-frozen and autogenous bone grafts. *Biomed Res Int*. 2014;2014:508328. doi:10.1155/2014/508328
17. Lumetti S, Consolo U, Galli C, et al. Fresh-frozen bone blocks for horizontal ridge augmentation in the upper maxilla: 6-month outcomes of a randomized controlled trial. *Clin Implant Dent Relat Res*. 2014;16(1):116-123. doi:10.1111/j.1708-8208.2012.00458.x
18. Leong DJ, Oh TJ, Benavides E, Al-Hezaimi K, Misch CE, Wang HL. Comparison between sandwich bone augmentation and allogenic block graft for vertical ridge augmentation in the posterior mandible. *Implant Dent*. 2015;24(1):4-12. doi:10.1097/ID.0000000000000180
19. Kloss FR, Offermanns V, Kloss-Brandstatter A. Comparison of allogeneic and autogenous bone grafts for augmentation of alveolar ridge defects-a 12-month retrospective radiographic evaluation. *Clin Oral Implants Res*. 2018;29(11):1163-1175. doi:10.1111/clr.13380
20. Blume O, Hoffmann L, Donkiewicz P, et al. Treatment of severely resorbed maxilla due to peri-Implantitis by guided bone regeneration using a customized allogenic bone block: a case report. *Materials (Basel)*. 2017;10(10):1213. doi:10.3390/ma10101213
21. Motamedian SR, Khojaste M, Khojasteh A. Success rate of implants placed in autogenous bone blocks versus allogenic bone blocks: a systematic literature review. *Ann Maxillofac Surg*. 2016;6(1):78-90. doi:10.4103/2231-0746.186143
22. Pereira E, Messias A, Dias R, Judas F, Salvoni A, Guerra F. Horizontal resorption of fresh-frozen Corticocancellous bone blocks in the reconstruction of the atrophic maxilla at 5 months. *Clin Implant Dent Relat Res*. 2015;17(Suppl 2):e444-e458. doi:10.1111/cid.12268
23. Schlee M, Rothamel D. Ridge augmentation using customized allogenic bone blocks: proof of concept and histological findings. *Implant Dent*. 2013;22(3):212-218. doi:10.1097/ID.0b013e3182885fa1
24. Tunkel J, de Stavola L, Kloss-Brandstatter A. Alveolar ridge augmentation using the shell technique with allogeneic and autogenous bone plates in a split-mouth design-a retrospective case report from five patients. *Clin Case Rep*. 2021;9(2):947-959. doi:10.1002/ccr3.3626
25. Khoury F, Hanser T. Three-dimensional vertical alveolar ridge augmentation in the posterior maxilla: a 10-year clinical study. *Int J Oral Maxillofac Implants*. 2019;34(2):471-480. doi:10.11607/jomi.6869
26. Wurdinger R, Donkiewicz P. Allogeneic cortical struts and bone granules for challenging alveolar reconstructions: an innovative approach toward an established technique. *J Esthet Restor Dent*. 2020;32(8):747-756. doi:10.1111/jerd.12639
27. Stimmelmayr M, Beuer F, Schlee M, Edelhoff D, Guth JF. Vertical ridge augmentation using the modified shell technique–a case series. *Br J Oral Maxillofac Surg*. 2014;52(10):945-950. doi:10.1016/j.bjoms.2014.08.009
28. Peck MT. Alveolar ridge augmentation using the allograft bone Shell technique. *J Contemp Dent Pract*. 2015;16(9):768-773. doi:10.5005/jp-journals-10024-1755
29. Kloss FR, Kammerer PW, Kloss-Brandstatter A. Risk factors for complications following staged alveolar ridge augmentation and dental implantation: a retrospective evaluation of 151 cases with allogeneic and 70 cases with autogenous bone blocks. *J Clin Med*. 2022;12(1):6. doi:10.3390/jcm12010006
30. Pabst A, Ackermann M, Thiem D, Kammerer P. Influence of different rehydration protocols on biomechanical properties of allogeneic cortical bone plates: a combined in-vitro/in-vivo study. *J Invest Surg*. 2021;34(10):1158-1164. doi:10.1080/08941939.2020.1767735
31. Aslan E, Gultekin A, Karabuda C, Mortellaro C, Olgac V, Mijiritsky E. Clinical, histological, and Histomorphometric evaluation of demineralized freeze-dried cortical block allografts for alveolar ridge augmentation. *J Craniofac Surg*. 2016;27(5):1181-1186. doi:10.1097/SCS.0000000000002548
32. Nkenke E, Schultze-Mosgau S, Radespiel-Troger M, Kloss F, Neukam FW. Morbidity of harvesting of chin grafts: a prospective study. *Clin Oral Implants Res*. 2001;12(5):495-502. doi:10.1034/j.1600-0501.2001.120510.x
33. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent*. 2003;23(4):313-323.
34. Sanz M, Vignoletti F. Key aspects on the use of bone substitutes for bone regeneration of edentulous ridges. *Dent Mater*. 2015;31(6):640-647. doi:10.1016/j.dental.2015.03.005
35. Draenert FG, Huetzen D, Neff A, Mueller WE. Vertical bone augmentation procedures: basics and techniques in dental implantology. *J Biomed Mater Res A*. 2014;102(5):1605-1613. doi:10.1002/jbm.a.34812
36. Danesh-Sani SA, Engebretson SP, Janal MN. Histomorphometric results of different grafting materials and effect of healing time on bone maturation after sinus floor augmentation: a systematic review and meta-analysis. *J Periodontal Res*. 2017;52(3):301-312. doi:10.1111/jre.12402
37. Schlee M, Dehner JF, Baukloh K, Happe A, Seitz O, Sader R. Esthetic outcome of implant-based reconstructions in augmented bone: comparison of autologous and allogeneic bone block grafting with the pink esthetic score (PES). *Head Face Med*. 2014;10:21. doi:10.1186/1746-160X-10-21
38. Perez-Gonzalez F, Molinero-Mourelle P, Sanchez-Labrador L, et al. Assessment of clinical outcomes and histomorphometric findings in alveolar ridge augmentation procedures with allogeneic bone block grafts: a systematic review and meta-analysis. *Med Oral Patol Oral Cir Bucal*. 2020;25(2):e291-e298. doi:10.4317/medoral.23353
39. Laino L, Iezzi G, Piattelli A, Lo Muzio L, Cicciu M. Vertical ridge augmentation of the atrophic posterior mandible with sandwich technique: bone block from the chin area versus corticocancellous bone block allograft—clinical and histological prospective randomized controlled study. *Biomed Res Int*. 2014;2014:982104. doi:10.1155/2014/982104
40. Starch-Jensen T, Deluiz D, Tinoco EMB. Horizontal alveolar ridge augmentation with allogeneic bone block graft compared with autogenous bone block graft: a systematic review. *J Oral Maxillofac Res*. 2020;11(1):e1. doi:10.5037/jomr.2020.11101
41. Aloy-Prosper A, Penarrocha-Oltra D, Penarrocha-Diago M, Penarrocha-Diago M. The outcome of intraoral onlay block bone grafts on alveolar ridge augmentations: a systematic review. *Med Oral Patol Oral Cir Bucal*. 2015;20(2):e251-e258. doi:10.4317/medoral.20194
42. Chiapasco M, Di Martino G, Anello T, Zaniboni M, Romeo E. Fresh frozen versus autogenous iliac bone for the rehabilitation of the extremely atrophic maxilla with onlay grafts and endosseous implants:

preliminary results of a prospective comparative study. *Clin Implant Dent Relat Res*. 2015;17(Suppl 1):e251-e266. doi:10.1111/cid.12191
43. Dellavia C, Giammattei M, Carmagnola D, Musto F, Canciani E, Chiapasco M. Iliac crest fresh-frozen allografts versus autografts in Oral pre-prosthetic bone reconstructive surgery: histologic and Histomorphometric study. *Implant Dent*. 2016;25(6):731-738. doi:10.1097/ID.0000000000000451
44. Penarrocha-Diago M, Aloy-Prosper A, Penarrocha-Oltra D, Calvo-Guirado JL, Penarrocha-Diago M. Localized lateral alveolar ridge augmentation with block bone grafts: simultaneous versus delayed implant placement: a clinical and radiographic retrospective study. *Int J Oral Maxillofac Implants*. 2013;28(3):846-853. doi:10.11607/jomi.2964
45. Weibull L, Widmark G, Ivanoff CJ, Borg E, Rasmusson L. Morbidity after chin bone harvesting—a retrospective long-term follow-up study. *Clin Implant Dent Relat Res*. 2009;11(2):149-157. doi:10.1111/j.1708-8208.2008.00102.x
46. Clavero J, Lundgren S. Ramus or chin grafts for maxillary sinus inlay and local onlay augmentation: comparison of donor site morbidity and complications. *Clin Implant Dent Relat Res*. 2003;5(3):154-160. doi:10.1111/j.1708-8208.2003.tb00197.x
47. Joshi A. An investigation of post-operative morbidity following chin graft surgery. *Br Dent J*. 2004;196(4):215-218; discussion 211. doi:10.1038/sj.bdj.4810987
48. Reissmann DR, Poxleitner P, Heydecke G. Location, intensity, and experience of pain after intra-oral versus extra-oral bone graft harvesting for dental implants. *J Dent*. 2018;79:102-106. doi:10.1016/j.jdent.2018.10.011
49. Iancu SA, Referendaru D, Iancu IA, Bechir A, Barbu HM. Immediate postoperative complications after lateral ridge augmentation-a clinical comparison between bone shell technique and sticky bone. *J Med Life*. 2022;15(4):533-538. doi:10.25122/jml-2021-0347
50. Tuna T, Yilmaz B, Hermanns-Sachweh B, Raith S, Wolfart S. From a CAD/CAM-milled, allogeneic bone block to an implant-supported fixed partial denture with angulated screw channel: a case report. *Quintessence Int*. 2021;52(1):56-63. doi:10.3290/j.qi.a45431
51. Hof M, Tepper G, Semo B, Arnhart C, Watzek G, Pommer B. Patients' perspectives on dental implant and bone graft surgery: questionnaire-based interview survey. *Clin Oral Implants Res*. 2014;25(1):42-45. doi:10.1111/clr.12061
52. Bawankar PV, Kolte AP, Kolte RA. Patient-centered outcome measures comparing the autogenous and allogenic bone blocks in the augmentation of deficient alveolar ridges: a pilot study. *J Indian Soc Periodontol*. 2023;27(1):87-94. doi:10.4103/jisp.jisp_733_21

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Heimes D, Pabst A, Becker P, et al. Comparison of morbidity-related parameters between autologous and allogeneic bone grafts for alveolar ridge augmentation from patients' perspective—A questionnaire-based cohort study. *Clin Implant Dent Relat Res*. 2023;1-13. doi:10.1111/cid.13242