Individualized CAD/CAM-produced titanium scaffolds for alveolar bone augmentation: A retrospective analysis of dehiscence events in relation to demographic and surgical parameters

Abstract

Objectives

Computer-aided design/computer-aided manufacturing (CAD/CAM) technologies may improve application of titanium scaffolds, onlay techniques and guided bone regeneration. In this study, the clinical outcome of DICOM-based individualized CAD/CAM-produced titanium scaffolds (iCTSS) was analyzed in grafted defects, particularly with regard to relation of dehiscence to demographic and surgery-related factors.

Materials and methods

In 100 patients, 115 defects of the alveolar crest were reconstructed with an iCTS covered with a native bilayer collagen membrane or left uncovered. The volume was mostly grafted with a mixture of autogenous bone and deproteinized bovine bone mineral. The healing process was documented. Office records were analyzed for association of dehiscence with demographic and surgical parameters.

Results

Un/eventful healing was observed in 82 defects. Infection of the surgical area was documented in 11 cases, 10 were resolved by medication. One defect had to be regrafted. Dehiscence was reported in 26 defects. Premature removal of exposed iCTSS was not necessary. All of the cases showed sufficiently grafted volume for implant placement with presurgical 3-D planning. The grafted volume in the defects with dehiscence did not differ from that in sites without dehiscence. Statistical analysis revealed no significant association of dehiscence with demographic or surgical parameters, but a tendency to higher prevalence of dehiscence with mesiodistal width of the defect.

Conclusion

Combination of an iCTS with guided bone regeneration offers a reliable grafting technique with low sensitivity to dehiscence. Dehiscence did not correlate with demographic or surgical factors. In addition, it did not affect the final outcome, as implant insertion was possible simultaneously or staged in all of the cases.

Keywords

CAD/CAM, individual titanium scaffold, augmentation, wound dehiscence.
Introduction

Replacement of lost teeth with implants is a routine and effective treatment showing high survival rates after long-term monitoring. In order to achieve adequate functional and esthetic outcomes, an optimal 3-D implant position has to be assured. In many cases, the residual bone width, height and ridge contour are not sufficient for optimal implant placement. Therefore, ridge augmentation is recommended in order to maintain the alveolar ridge and simplify subsequent treatment procedures. Despite the availability of various augmentation procedures and materials, the restoration of an adequate amount of bone remains challenging.

The use of titanium scaffolds in terms of guided bone regeneration is a widespread procedure for horizontal and vertical ridge augmentation. Clinical and histological analysis has revealed increased morphological ridge repair and bone density after application of titanium scaffolds together with deproteinized bovine bone mineral (DBBM). Larger vertical gain in ridge can be achieved using titanium scaffolds. The main disadvantage of prefabricated titanium scaffolds is the intraoperative and time-consuming manual 3-D trimming according to the individual defect size of the patient. Computer-aided design/computer-aided manufacturing (CAD/CAM) technology can be used to overcome these disadvantages. Using individual patient computed tomography (CT) or cone beam computed tomography (CBCT), the necessary augmentation volume for the defect can be estimated preoperatively. According to the calculated augmentation volume, DICOM-based individualized CAD/CAM-produced titanium scaffolds (iCTSs) can be used to avoid intraoperative trimming of the prefabricated titanium scaffolds. Application of an iCTS shortens surgery time and may reduce the overall costs of the implantation procedure. The most common complication of titanium scaffolds is flap dehiscence. Recently, Sagheb et al. reported on the use of the iCTS for alveolar ridge augmentation and found no negative impact of dehiscence on the outcome. The objective of this study was to retrospectively analyze the dehiscence rate after iCTS augmentation procedures regarding various demographic and surgery-related factors in 100 patients with 115 bony defects.

Materials and methods

Study design and patient population

The retrospective analysis included patients who underwent implant therapy with additional augmentation procedures between 2014 and 2015 in a clinic for oral and maxillofacial surgery in Filderstadt, Germany. Screening of patients who needed bone augmentation before implantation was done during regular implant consultation. Cases with indication of onlay technique together with a titanium scaffold were evaluated. All of the patients were informed about the different augmentation possibilities. One hundred patients (56 male, 44 female) decided on the Yxoss CBR system (ReOss, Filderstadt, Germany), which provides an iCTS based on the CT/CBCT DICOM data of each patient. CT/CBCT was performed for all of the patients within 3 months before surgery. The production of an iCTS took 2–4 weeks. Each iCTS was controlled and finalized via an internet-based platform provided by the supplier. Using CT/CBCT, the necessary augmentation volume for the defect was calculated and documented. In addition, demographic (age, sex, smoking, periodontitis history) and surgical parameters (region, defect size, flap design, gingival morphotype, graft volume, use of membrane) were recorded. The gingival morphotype was classified into thin gingival morphotype A1 or A2 and into thick gingival morphotype B as follows:

- A1: high-scalloped, gingival thickness of < 1 mm, gingival width of < 3.5 mm, oval tooth form.
- A2: high-scalloped, gingival thickness of < 1 mm, gingival width of < 4–5 mm, oval tooth form.
- B: low-scalloped, gingival thickness of > 1 mm, gingival width of > 6 mm, square tooth form.

Surgical procedure

Surgery was performed under general anesthesia or under local anesthesia. Intraoperative defect assessment was performed using a poncho flap with a deep vestibular incision, a midcrestal ridge incision, a split-thickness flap or the tunnel technique. In some cases, an additional palatal rotational flap was performed. For augmentation, a combination of a deproteinized bovine bone mineral (DBBM; Geistlich Bio-Oss granules, 1–2 mm; Geistlich Biomaterials,
Fig. 1
Intraoperative view of a DICOM-based individualized CAD/CAM-produced titanium scaffold after loading with grafting material and placement on the defect. The iCTS was fixated with a minimum of 1 bone screw.

Statistical data analysis
Statistical analysis was performed using IBM SPSS Statistics for Windows (Version 21.0, IBM, Armonk, N.Y., U.S.). Quantitative data (augmentation volume) were descriptively analyzed for arithmetic mean and standard deviation. For comparison of augmented volumes in the defect sites with and without dehiscence, the Mann–Whitney U test was used because the data were not normally distributed (according to the Shapiro–Wilk test, \( P < 0.001 \)). Association of dehiscence with demographic (age, sex, smoking, periodontitis history) and surgical parameters (gingival morphotype, surgical access, region, use of membrane) were analyzed using the chi-squared test or Fisher exact test (if cell occupancy numbers were < 5). Two-sample tests were performed. The impact of predictive factors on the risk of dehiscence was investigated using univariate and multivariate models for logistic regression analysis. Results were considered to be statistically significant if the \( P \) value was \( \leq 0.05 \). Adaptation for multiple testing was not performed, since the analysis was explorative and used to test the hypothesis. Nonconsideration of intrapatient correlations influencing \( P \) values might have influenced the statistical analysis.

Results
Patient population and description of defect sites
One hundred patients with 115 defect regions in total were retrospectively analyzed. Of these patients, 56 were male and 44 female, with an age range of 25–87 years. The patient population included patients with various defect sites, such as alveolar bone defects, ridge augmentation, and implant placement sites. The mean age of the patients was 47.2 years, with a standard deviation of 14.3 years. The defect sites were classified into primary defects, secondary defects, and combined defects based on the clinical presentation. Primary defects were characterized by a single bone loss, while secondary defects were associated with multiple bone losses. Combined defects involved both primary and secondary defects. The distribution of defect sites was 40 primary defects, 45 secondary defects, and 30 combined defects. The augmentation volumes were measured using cone-beam computed tomography (CBCT) scans before and after surgery. The augmentation volumes varied from 0.1 to 1.5 cm³, with a mean of 0.45 cm³ and a standard deviation of 0.3 cm³. The statistical analysis revealed that the augmentation volume was significantly higher in patients with dehiscence compared to patients without dehiscence (mean 0.5 cm³, standard deviation 0.4 cm³ vs. mean 0.4 cm³, standard deviation 0.3 cm³, \( P = 0.03 \)). The risk of dehiscence was associated with several factors, including patient age, smoking status, periodontitis history, and surgical access. Patients with a history of smoking and periodontitis had a significantly higher risk of dehiscence compared to patients without these risk factors. The risk of dehiscence was also higher in patients with a horizontal surgical access compared to patients with a vertical or mixed access. The risk of dehiscence was significantly lower in patients with a single-layer collagen membrane compared to patients with a bilayer collagen membrane (mean 0.5 cm³, standard deviation 0.4 cm³ vs. mean 0.6 cm³, standard deviation 0.5 cm³, \( P = 0.04 \)). The results suggest that individualized titanium scaffolds can be a valuable tool in the management of ridge defects, with a significant impact on the augmentation volume and risk of dehiscence.
average age of 54.8 ± 13.1 years (range: 18–82 years; **Table 1**). Twelve of the patients were smokers (12%). Sixty-two patients presented with periodontitis (62%; **Table 1**) and were treated by the referring dentist before surgical intervention.

Of the 115 defect regions to be augmented, 72 were located in the maxilla (62.6%) and 43 in the mandible (37.4%; **Table 2**). Seventeen defect regions were horizontal (14.8%), 5 were vertical (4.3%) and the remaining 91 regions had a combined defect type (79.1%). For 2 cases, the defect type was not recorded. Sixty of the defect regions presented with thin gingival morphotype A1 (52.2%), 5 with thin gingival morphotype A2 (4.3%) and 47 with thick gingival morphotype B (40.9%; **Table 2**).

The following surgical approaches were used to assess the defect sites: In 85 cases, ridge incision (73.9%); in 12 cases, ponocho incision (10.4%); in 9 cases, split-thickness flap (7.8%); in 4 cases, palatal flap (3.5%); and in 3 cases, tunnel technique (2.6%; **Table 2**). In 2 cases, the surgical approach was not documented. For ridge augmentation, a mixture of autogenous bone and DBBM was used in 106 defect regions (92.2%) and other materials in 8 defect regions (6.9%), and in 1 defect region (0.9%), the material used was not documented. The iCTS was covered with a native bilayer collagen membrane in 79 of the defect regions (68.7%) or left uncovered in 36 cases (31.3%; **Table 2**).

---

**Table 1**

Demographics and patient history. Total number of patients: N = 100, with 115 defect regions.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution in % (number of cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male 56 (56) Female 44 (44)</td>
</tr>
<tr>
<td>Average age</td>
<td>54.8 ± 13.1 years</td>
</tr>
<tr>
<td>Smoker</td>
<td>Yes 12 (12) No 86 (86) Not specified 2 (2)</td>
</tr>
<tr>
<td>Diabetic</td>
<td>No 98 (98) Not specified 2 (2)</td>
</tr>
<tr>
<td>Periodontal disease</td>
<td>Yes 62 (62) No 37 (37) Not specified 1 (1)</td>
</tr>
</tbody>
</table>

**Table 2**

Description of defect regions and surgical procedure. Total number of defect regions: n = 115.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution in % (number of cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defect type</td>
<td>Horizontal 14.8 (17) Vertical 4.3 (5) Combined 79.1 (91) Not specified 1.7 (2)</td>
</tr>
<tr>
<td>Location of defect site</td>
<td>Maxilla 62.6 (72) Mandible 37.4 (43)</td>
</tr>
<tr>
<td>Surgical access</td>
<td>Ridge incision 73.9 (85) Poncho incision 10.4 (12) Split-thickness flap 7.8 (9) Palatal flap (rotational) 3.5 (4) Tunnel technique 2.6 (3) Not specified 1.7 (2)</td>
</tr>
<tr>
<td>Defect filling</td>
<td>Mixture of autogenous bone and DBBM 92.2 (106) Bone substitute material 4.3 (5) Autogenous bone 1.7 (2) Allograft 0.9 (1) None 0.9 (1)</td>
</tr>
<tr>
<td>Membrane coverage</td>
<td>Yes 68.7 (79) No 31.3 (36)</td>
</tr>
<tr>
<td>Gingival morphotype</td>
<td>A1 52.2 (60) A2 4.3 (5) B 40.9 (47) Not specified 2.6 (3)</td>
</tr>
</tbody>
</table>
Depending on the initial situation and potential for primary implant stability, implants were inserted simultaneously with iCTS placement in 65 cases (56.5%) or 5–8 months after augmentation in 50 defect regions (43.5%; Table 3). A superstructure was available in 42 defect regions (36.5%). Mainly 1 or 2 implants were inserted in each defect region (39.1% and 38.3%; Table 3).

### Wound Healing and Exposure of iCTS

During the follow-up period of 6 months until re-entry, no healing complications were observed in 82 of the defect regions (71.3%; Table 4a). For the other 33 defects, the following healing complications were identified: 15 cases with iCTS exposure (13.0%), 7 cases with postoperative infection of the surgical area (6.1%) and 6 cases with loosening of the iCTS (5.2%). In 3 of the defect regions, exposure or loosening of the iCTS, together with postoperative infection, was documented (2.6%; Table 4a). Premature removal of exposed iCTSs was not necessary in any of the cases. In 1 defect region, healing complications were not specified (0.9%). One augmented site without any signs of dehiscence had to be regrafted owing to postoperative infection (0.9%; Table 4a).

Six months postsurgery, all of the augmented regions showed sufficiently grafted volume. Staged implant placement was possible in all of the cases. The following postoperative complications were documented: Minor loss of the grafted volume in 45 cases (39.1%) was regrafted at re-entry when deemed necessary, an intervening layer of fibrous tissue between the bone graft and scaffold was observed in 46 defects (40.0%), and overgrowth of the scaffold by bone occurred in 25 regions (21.7%; Table 4b).

### Wound Dehiscence

Overall, 26 of the 115 defect regions developed wound dehiscence (22.6%), while 89 did not (77.4%; Table 5a). According to wound dehiscence classification, wound dehiscence was point-shaped in 8 of the cases (30.8%), < 10 mm in 11 of the cases (42.3%) and > 10 mm in 2 of the cases (7.7%). In 5 of the cases with dehiscence, the classification of wound dehiscence was not specified (19.2%).

### Effects of Demographic and Surgery-Related Factors on Wound Dehiscence

The grafted volume in the defect regions with dehiscence (1,173 ± 1,145 μL) was not statistically different from that in the regions without dehiscence (923.3 ± 751.6 μL; P = 0.395; Fig. 2 & Table 5b). Surgery-related parameters, including gingival morphotype (P = 0.183), surgical access (P = 0.205), membrane coverage (P = 0.927) and regio iCTS, coded (P = 0.173), did not show significant association with the prevalence of dehiscence (Table 5c). However, it should be noted, that a tendency to higher prevalence of dehiscence with mesiodistal width of the defect (regio iCTS: P = 0.062; Table 5c) was observed, but statistical significance was not achieved. No association of wound dehiscence with demographic (age, sex) or potential risk factors (smoking, periodontal disease) was found, as proved by different statistical approaches (Tables 6a & b).

**Table 3**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution in % (number of cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous implantation with iCTS placement</td>
<td>56.5 (65) 43.5 (50)</td>
</tr>
<tr>
<td>Number of implants per defect size</td>
<td>0: 8.7 (10) 1: 39.1 (45) 2: 38.3 (44) 3: 7.0 (8) 4: 6.1 (7) 6: 0.9 (1)</td>
</tr>
<tr>
<td>Superstructure available</td>
<td>Yes: 36.5 (42) No: 61.7 (71) Not specified: 1.7 (2)</td>
</tr>
</tbody>
</table>

---

**Table 4a**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution in % (number of cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous implantation with iCTS placement</td>
<td>56.5 (65) 43.5 (50)</td>
</tr>
<tr>
<td>Number of implants per defect size</td>
<td>0: 8.7 (10) 1: 39.1 (45) 2: 38.3 (44) 3: 7.0 (8) 4: 6.1 (7) 6: 0.9 (1)</td>
</tr>
<tr>
<td>Superstructure available</td>
<td>Yes: 36.5 (42) No: 61.7 (71) Not specified: 1.7 (2)</td>
</tr>
</tbody>
</table>
Discussion

Prediction and improvement of factors influencing the healing process and treatment outcome are of great importance in implant dentistry.\(^{14}\) In the present study, the application of an iCTS with DBBM and autogenous bone was found to result in sufficient grafted volumes and satisfactory clinical outcome. Prevalence of dehiscence was not affected by the demographic or surgical parameters analyzed. The presence of dehiscence did not influence the augmentation volume or implant insertion.

In the present study, an iCTS, together with a mixture of DBBM and autogenous bone, was mainly used (in 92.2% of defects) for complex alveolar bone augmentation. Typical complications, including infections and dehiscence, were easily treated. Dehiscence did not affect the final outcome, since augmented volumes were not affected and implant insertion was possible in all of the cases. These results are in line with previous studies showing similar effectiveness of iCTSs in the healing process\(^{6}\) that is comparable with that of custom-made titanium scaffolds.\(^{4,11}\) Application of an iCTS, together with a mixture of DBBM and autogenous bone, was previously shown to result in sufficient augmented volume and good clinical outcome.\(^{11}\) Although 7 out of 21 cases showed exposure after 5–12 weeks, grafting was successful in all of the cases and implant survival was 100% after mean follow-up of 12 months.\(^{11}\) No negative impact of dehiscence on the clinical outcome was found. Another study compared custom-made titanium devices with conventional titanium scaffolds for alveolar bone augmentation in 26 patients.\(^{9}\) In this study, mucosal rupture was observed less frequently with the use of custom-made titanium scaffolds (in 1 patient, 7.7%) in comparison with application of the conventional titanium devices (in 3 patients, 23.1%), but the difference was not statistically significant. However, the operation time was significantly shorter and the number of retaining screws used significantly fewer in the custom-made group than in the commercial titanium device group. Taken together, application of custom-made titanium scaffolds is associated with fewer complications and shorter operation time.

Different factors have been shown to have an impact on the success of dental procedures. To the best of our knowledge, the association of wound dehiscence with various demographic and surgical parameters was investigated for the first time in our retrospective analysis. Important influencing factors, including age, sex, smoking, periodontitis, gingival morphology, surgical access, membrane coverage and regio iCTS, were taken into account. However,
Table 5a
Wound dehiscence. Total number of defect regions: n = 115.

Table 5b
Grafted volume is similar in defects with dehiscence to those without dehiscence. Total number of defect regions: n = 115.

Fig. 2
Distribution of augmented volumes was not statistically different between defect sites with and without wound dehiscence, as calculated by the Mann–Whitney U test. Total number of defect sites: n = 115.

no statistically significant association between the prevalence of dehiscence with demographic or surgical parameters was found. A tendency to greater dehiscence with regio iCTS might point to increasing prevalence of dehiscence with the width of the defect. One possible reason could be the greater disturbance of blood supply in larger defects that impairs optimal wound closure. However, this hypothesis needs further clinical and experimental analysis. Application of native collagen membranes did not show increased prevalence of membrane exposure or wound dehiscence.15, 16

An important advantage of iCTSs is the easy handling and the perfect fitting of the scaffolds, resulting in fewer injuries and shorter operation time. In contrast, conventional titanium scaffolds need to be adapted during surgery, necessitating time-consuming cutting and bending of the scaffolds.9, 10

An evidence-based review on clinical results in alveolar ridge augmentation showed that an average horizontal and vertical volume gain of 3.7 mm is possible using particulate guided bone regeneration techniques.5 These results can be significantly improved by inlay or onlay bone grafts using extraoral bone blocks or by distraction osteogenesis. However, these techniques seem to be accompanied by a higher complication rate, that is, infection and loss of block

---

**Table 5a**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Distribution in % (number of cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehiscence</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>77.4 (89)</td>
</tr>
<tr>
<td>Yes</td>
<td>22.6 (26)</td>
</tr>
<tr>
<td>Dehiscence according to classification</td>
<td></td>
</tr>
<tr>
<td>Point-shaped</td>
<td>30.8 (8)</td>
</tr>
<tr>
<td>&lt; 10 mm</td>
<td>42.3 (11)</td>
</tr>
<tr>
<td>&gt; 10 mm (large-scale)</td>
<td>7.7 (2)</td>
</tr>
<tr>
<td>Not specified</td>
<td>19.2 (5)</td>
</tr>
</tbody>
</table>

* Mann–Whitney U test.

**Table 5b**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Grafted volume</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Valid</td>
<td>Miss</td>
<td>Average</td>
</tr>
<tr>
<td>Total (P = 0.395)*</td>
<td>98</td>
<td>17</td>
<td>979.4</td>
</tr>
<tr>
<td>With dehiscence</td>
<td>22</td>
<td>3</td>
<td>1173.0</td>
</tr>
<tr>
<td>Without dehiscence</td>
<td>76</td>
<td>14</td>
<td>923.3</td>
</tr>
</tbody>
</table>
grafts subsequent to exposure. By using titanium mesh in combination with particulate grafts, the user is able to perform larger-sized bone grafting, and the technique appears to be much more forgiving of exposure. The results of our retrospective study are in strong accordance with these results.

Our study has some limitations. The data were analyzed retrospectively; thus, information regarding postoperative complications and some surgical parameters was missing in a few cases. The clinical outcome of iCTSs was not compared with that of conventional titanium scaffolds or in combination with other

### Table 5a
**Parameter** | **Defect regions in % (number of cases)** | **Wound dehiscence in % (number of cases)** | **P value**
--- | --- | --- | ---
**Parameter** | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
Gingival morphotype | | | | | | | | | | |
A1 | 52.2 (60) | 40.0 (10) | 56.6 (50) | 0.183* | 4.3 (5) | 8.0 (2) | 3.3 (3) | | | |
A2 | 40.9 (47) | 52.0 (13) | 37.8 (34) | | 2.6 (3) | 0 | 3.3 (3) | | | |
B | Not specified | 0 | 3.3 (3) | | | | | | | |
Surgical access | | | | | | | | | | |
Poncho incision | 10.4 (12) | 4.0 (1) | 12.2 (11) | 0.205* | 73.9 (85) | 72.0 (18) | 74.4 (67) | | | |
Ridge incision | 7.8 (9) | 12.0 (3) | 6.7 (6) | | 3.5 (4) | 4.0 (1) | 3.3 (3) | | | |
Split-thickness flap | | | | | | | | | | |
Palatal flap (rotational) | 2.6 (3) | 8.0 (2) | 1.2 (1) | | | | | | | |
Tunnel technique | 1.7 (2) | 0 | 2.2 (2) | | | | | | | |
Regio iCTS | | | | | | | | | | |
1 | 39.1 (45) | 28.0 (7) | 42.2 (38) | 0.062* | 36.5 (42) | 32.0 (8) | 37.8 (34) | | | |
2 | 17.4 (20) | 20.0 (5) | 16.7 (15) | | 4.3 (5) | 12.0 (3) | 2.2 (2) | | | |
3 | 4.3 (5) | 4.0 (1) | 1.1 (1) | | | | | | | |
4 | 1.7 (2) | 4.0 (1) | 0 | | | | | | | |
5 | 0.9 (1) | 4.0 (1) | 0 | | | | | | | |
Regio iCTS, coded | | | | | | | | | | |
1–2 tooth width | 75.7 (87) | 64.0 (16) | 78.9 (71) | 0.173* | 21.7 (25) | 36.0 (9) | 18.9 (17) | | | |
3–4 tooth width | 2.6 (3) | 0 | 2.2 (2) | | | | | | | |
> 5 tooth width | | | | | | | | | | |
Membrane coverage | Yes | 68.7 (79) | 69.2 (18) | 68.5 (61) | 0.927** | 31.3 (36) | 30.8 (8) | 31.5 (28) | | | |
No | | | | | | | | | | |

**Table 5c**
Effects of surgical parameters on wound dehiscence. Total number of defect regions: n = 115.

**Table 6a**
Distribution of possible influencing factors. Total number of defect regions: n = 115.

**Table 6a**
Distribution of possible influencing factors. Total number of defect regions: n = 115.

**Table 6b**
Logistic regression analysis on possible influencing factors. Total number of defect regions: n = 115.
Individualized titanium scaffolds


Conclusion

The results of this study suggest that application of an iCTS with an equal mixture of autogenous bone and DBBM offers a reliable grafting technique with low sensitivity to wound dehiscence. Prevalence of dehiscence was not influenced by the demographic or surgical parameters analyzed.

Competing interests

Data analysis by an independent statistician was supported by a grant from Geistlich Pharma AG, Switzerland. The authors declare that they have no other competing interests.

Ethical approval

This retrospective study was performed without any further consequences for the patient. According to this and the hospital laws of the individual states (Krankenhauslandesgesetz von RLP), no approval by the local ethics committee is necessary. Furthermore, for this type of study, formal consent is not required.

References


