Sinus floor augmentation with simultaneous placement of dental implants in the presence of platelet-rich plasma or recombinant human bone morphogenetic protein-7

Key words: anorganic bovine bone, bone morphogenetic proteins, dental implants, platelet-rich plasma, sinus floor augmentation

Abstract: The aim of the present study was to evaluate the possible benefit of platelet-rich plasma (PRP) in sinus grafting as compared with recombinant human bone morphogenetic protein-7 (rhBMP-7). For this purpose, we performed a bilateral sinus augmentation with anorganic bovine bone and simultaneous insertion of a titanium screw implant in five miniature pigs. Six hundred microliters of PRP and 15%-vol. autologous bone, which was collected with a trap during preparation of the implant recipient site, were added to the right sinus and 420 \( \mu l \) rhBMP-7 to the left sinus. A polychrome sequential labeling was performed. The animals were sacrificed 6 weeks after surgery. Undecalcified ground sections were evaluated by microradiography, digitized histomorphometry and under fluorescent light. The mean bone–implant contact using rhBMP-7 was 45.8% and 5.7% under PRP (\( P = 0.002 \)). The mean height of newly mineralized bone in the augmented area using rhBMP-7 amounted to 8.3 mm as opposed to 3.6 mm under PRP (\( P = 0.013 \)). Using PRP, the mean area of the newly formed bone was enhanced (51.3%) as compared with rhBMP-7 (33.1%); however, this difference was not statistically significant (\( P = 0.081 \)). In conclusion, under the selected experimental conditions the use of rhBMP-7 led to superior outcomes with regard to the osseointegration of dental implants and the height of new bone as compared with the use of PRP.
autologous platelet-rich plasma (PRP) to accelerate the maturation of grafted bone in maxillofacial surgery. Growth factors released by platelets like PDGF, IGF-I and transforming growth factor-β (TGF-β) are involved in reparative processes including osteogenesis (Ross et al. 1986; Noda & Camillière 1989; Pfeilschifter et al. 1990; Nash et al. 1994). Lynch [1999] proposed the use of PRP in combination with a bone substitute for the treatment of small bone defects in periodontal and implant surgery. Since 2000, clinical studies have been published to evaluate the benefit of PRP in sinus surgery [Kassolis et al. 2000; Rosenberg & Torosian 2000; Lozada et al. 2001; Philippart et al. 2003; Rodriguez et al. 2003; Wiltfang et al. 2003]. At present, there are no data available from experimental in vivo studies on the histomorphometric evaluation of new bone formation and osseointegration of dental implants in the presence of PRP.

Bone morphogenetic proteins (BMPs), on the other hand, are able to induce mesenchymal stem cells to differentiate into osteoblasts and to produce new bone tissue [Urist 1965]. BMPs have been shown to shorten the healing time of sinus augmentation in combination with a bone substitute and to increase the osseointegration of dental implants [Boyne et al. 1997; Hansch et al. 1997; Margolin et al. 1998; Terheyden et al. 1999]. Therefore, the aim of the present study was to evaluate the pattern of bone formation using PRP compared with the well-documented effects of a recombinant BMP in the miniature pig model for sinus augmentation.

Material and methods

The study was approved by the Ministry of Nature, Environment and Forestry of Schleswig-Holstein in accordance with the ethics committee of this institution [V 252-72241. 121-14]. Five miniature pigs (Ellengard Göttingen Minipigs ApS, Dalmore, Denmark), 18 months of age, which weighed 40 kg, were operated. They were fed with 2 × 250 g standard soft diet (Altromin 9023® Atronium International GmbH, Lange, Germany) and water ad libitum. Anesthesia was induced with 30 mg Ketamine (Ketavet®, Upjohn GmbH, Heppenheim, Germany) and 1 mg Xylazine (Rompun® 2%, Bayer AG, Leverkusen, Germany). An intratracheal intubation was performed with a Miller size 4 laryngoscope and a standard straight 5.5 mm ID tube with cuff (Portex, Kent, UK). Anesthesia was maintained with gas (66% \(\text{N}_2\text{O}\) and 32% \(\text{O}_2\) [Forene®, Abbot GmbH, Wiesbaden, Germany]). One gram Clemizol–Penicillin (Clemizol–Penicillin® i.m. forte, Grünenthal GmbH, Aachen, Germany) was given preoperatively as a prophylactic antibiotic. Postoperative pain relief was achieved before extubation by injecting 500 mg metamizol i.m. [Novalgin®, Hochst AG, Bad Soden, Germany], continuing with 2 × 50 mg/day p.o. Tramadol [Tramal®, Grünenthal GmbH, Aachen, Germany].

Preparation of PRP

Seventeen milliliters of blood were collected in two vacuum tubes of 8.5 ml each [S-Monovette®, CPDA-1, Starstedt AG, Nürnberg, Germany] from the vena jugularis interna in general anesthesia just before surgery. The method proposed by Marx et al. [1998] on how to prepare PRP was modified according to the small volumes handled are proportional to the volumes described by Marx et al. [1998]. The PRP was produced as follows: the whole blood was centrifuged for 7 min at 1700 rpm without brake. The plasma was decanted down to the erythrocyte sediment and then centrifuged again for 10 min at 3000 rpm with brake. Finally, the plasma was decanted and the sediment was resuspended with 2.5 ml plasma, resulting in the same concentration of PRP as the one described by Marx et al. [1998]. The platelets in whole blood and PRP were counted manually in the Neubauer chamber in which the thrombocytes were stained manually with a specific reagent [TTV 55-Thrombozyten-Einzeltest® KABE Labotechnik GmbH, Nürnberg-Eisenroth, Germany]. The PRP was kept in a sample shaker for a mean of 30 min at room temperature. The PRP for clinical use was activated with 250 mg Zolazepam/250 mg Tiletamin HCl (Rompun®, Upjohn GmbH, Heppenheim, Germany) and continued for 3 weeks with 250 mg Zoletil® 50 (500 Parke-Davis, Freiburg, Germany) started 2 weeks after the surgical procedure and continued for 3 weeks with labeling per week as follows: xylanol-orange [6% in 2% \(\text{NaHCO}_3\) solution, 1.5 ml/kg body weight], calcein green [1% in 2% \(\text{NaHCO}_3\) solution, 5 ml/kg body weight], and eighty microliters of this solution were used in combination with the anorganic bovine bone and 15% vol. autologous bone for implantation in the right sinus.

Experimental procedure

After harvesting of blood to prepare PRP, the cheek was shaved and cleaned with povidone–iodine solution and draped with sterile towels. The augmentation of the sinus was achieved by an infraorbital access and subperiosteal preparation of the facial maxillary bone, the crista zygomaticoalveolaris and the malar prominence, as previously described [Terheyden et al. 1999]. The access to the sinus was achieved by thinning the facial wall with a surgical bur. The Schneiderian membrane was carefully elevated within the sinus, particularly below the malar prominence, where the dental implant in a latero-cranial direction was inserted. The malar bone, as an implant site, was reduced to a height of 5 mm for standardization according to the clinical situation [Tidwell et al. 1991; Triplet & Schow 1996]. Solid screw titanium implants (SLA-ITI®, Strauman AG, Waldenburg, Switzerland), 16 mm long with a diameter of 4.1 mm, were used. The right sinus was augmented with 3 ml anorganic bovine bone [Bio-Oss® Granulat 0.25–1 mm, E. Geistlich Söhne AG, Wolhusen, Switzerland], 15%-vol. autologous bone collected during preparation of the implant recipient site with a bone trap in a suction device [Knochensplitter T3, Schuminum OHG®, Broichstedt, Germany] and 600 μl PRP. The left sinus was augmented with 3 ml Bio-Oss® and 420 μl recombinant BMP-7 [rhBMP-7] [Stryker Biotech, Hopkinton MA, USA] in 600 μl acetaet buffer. No autologous bone was grafted into the left sinus.

Polychrome sequential labeling

A polychrome sequential labeling of mineralizing tissues according to Rahn [1976] was performed as previously described [Terheyden et al. 1999]. Intraperitoneal injection of fluorochromes under i.m. anesthesia with 250 mg Zolazepam/250 mg Tiletin [Tilet® 500 Parke-Davis, Freiburg, Germany] started 2 weeks after the surgical procedure and continued for 3 weeks with labeling per week as follows: xylanol-orange [6% in 2% \(\text{NaHCO}_3\) solution, 1.5 ml/kg body weight], calcein green [1% in 2% \(\text{NaHCO}_3\) solution, 5 ml/kg body weight],
alizarin complexon (3% in 2% NaHCO₃ solution, 0.8 ml/kg body weight) and doxycycline® (1 mg/kg body weight, Doxycyclin-Rathiopharm SF®, Rathiopharm GmbH & Co., Ulm, Germany).

**Sacrifice**
The animals were sacrificed 6 weeks postsurgery in general anesthesia (see above) by an intravital and intracardial perfusion. For this purpose, the ascending aorta, after a median thoracotomy, was canulated through an incision of the left ventricle. Prior to this, heparin 40 IU/kg (Liquemin® N 2500, Hoffmann-La Roche AG, Grenzach-Wyhlen, Germany) had been administered. The right atrium was opened by an incision to release the venous blood flow. Two liters of Ringer solution was perfused at a temperature of 36–37°C under 120 mmHg pressure in order to wash out the blood. Subsequently, the animals were perfused for tissue fixation with a 500 ml solution composed of 25% glutaraldehyde (2.5%), formaldehyde (1.5%) and Sörensen’s phosphate buffer (100 mM KH₂PO₄, 100 mM Na₂HPO₄ × 2H₂O, pH 7.4). A coronal computed tomography (CT) Scan (Siemens Somatom Plus, Siemens AG, Munich, Germany; 120 kV, 33 mA) was conducted. The explanted sinus was immersed in 10% formalin, Sörensen’s phosphate buffer and 70% isopropyl alcohol for 10 days.

**Histology**
Undecalciﬁed specimens were prepared according to the method described by Donath & Breuner [1982]. The process consists in a gradual dehydration of the specimen in ethyl alcohol and a final embedding in acrylic resin (Fluka Chemie AG, Buchs, Switzerland). The block was cut in the coronal plane after placing an implant abutment that indicated the axis of the implant body. The retrieved specimens, in 0.5 mm slices, were ﬁxed on an acrylic carrier and ground and polished down to approximately 90 μl. A microradiographic (Type 1A, Microchrome Technology Inc., San José, CA, USA) was taken at 3 mA and 25 kV using a microradiography device [Faxitron X-ray systems, Hewlett Packard GmbH, Böblingen, Germany]. The histomorphometry of the total core was evaluated after digitalization of the microscope image. The software detected a variety of different gray tones, which allowed to distinguish the newly mineralized bone (Q500MC®, Leach Cambridge Ltd., Cambridge, UK). Fluorescence microscopy was performed under UV light. The parameters to be evaluated according to Parfitt et al. [1987] were the following:

- **Bone–implant contact:** Mineralized bone in direct contact to the implant (%), where 100% is the total length of the implant in the augmented sinus.
- The area of newly mineralized bone in the lower third of the augmented area (mm²)
- Height of newly mineralized bone in the augmented area (mm).

**Statistical analysis**
The data for the three outcome variables were analyzed with a paired t-test. The correlation in the thrombocyte count in whole blood and PRP was analyzed with a Spearman test. The significance level was set at $P < 0.05$.

**CT scan**
Six weeks after the operation no signs of infection in the maxillary sinus, of any loss of implant integration or any apparent differences in the imaging of the augmentation with PRP or with rhBMP-7 could be observed (Fig. 1).

**Results**

**Validity of the preparation of PRP**
The mean number of thrombocytes in whole blood was $450,200 \pm 10^3$ cells/μl. The PRP mean platelet count was $1,592 \times 10^3$ cells/μl. Thus, the concentration of the thrombocytes in PRP was increased by a factor of 3.5. The thrombocyte count in whole blood in the different animals was variable, ranging from $173 \times 10^3$ to $620 \times 10^3$ cells/μl. No statistically significant correlation between the thrombocyte concentration in the whole blood and in PRP could be observed ($P = 0.1$).

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**Fig. 1.** Coronal CT Scan (Siemens Somatom Plus, 120 kV, 33 mA) of the midface of a miniature pig 6 weeks after sinus-lift with anorganic bovine bone in association with platelet-rich plasma and 15%-vol. autologous bone on the right side and with bone morphogenetic protein-7 on the left side. A titanium screw implant was primarily inserted into the zygomatic bone in a latero-cranial direction on both sides. No sinus pathology or apparent difference in the radio-opacity of the augmentation is seen on both sides. The right maxillary sinus is outlined in red, the left sinus in blue, the infraorbital nerve [n] is demarked in yellow on both sides.
Microradiography
In the presence of PRP, the apposition of new bone could be seen in the proximity of host bone but not on top of the augmentation [Fig. 2a]. The formation of new bone in the presence of rhBMP-7 appeared to be homogeneous in the whole augmented area and limited to the area augmented with bone substitute [Fig. 2b].

Toluidine blue histology
No inflammatory reaction was seen on any section and individual animal. An enhancement of bone apposition in the proximity of host bone in the presence of PRP was clearly detected; however, osseointegration was not improved. Bio-Oss® particles on top of the dental implant are surrounded by connective tissue. The sinus wall is outlined in red, the arrow indicates apposition of new bone on the implant [Fig. 3a]. In contrast, bone marrow was observed in the whole augmented sinus in the presence of rhBMP-7 and the implants were surrounded by newly formed bone in all the cases [Fig. 3b].

Fluorescence microscopy
The apposition of new bone was observed in the presence of rhBMP-7 after the second week postsurgery, in the presence of PRP it occurred 1 week later, as indicated by the second labeling [Fig. 4]. Bone apposition was enhanced on the sinus floor showing wider labeled bands in both experimental groups. No bone apposition was seen on the tip of the implants in sites treated with PRP. In the presence of rhBMP-7, however, a homogeneous bone apposition on the top of the implants and around the Bio-Oss®.
particles could be seen after the second postoperative week.

**Histomorphometry**

In all but one specimen, apposition of bone on dental implants was seen in the PRP group. The mean BIC in the presence of PRP amounted to 5.76%, whereas in the rhBMP-7 group BIC was observed over the entire implant length with a mean value of 45.8%. This difference was statistically significant ($P = 0.002$). The mean height of the newly formed bone in the augmented area in rhBMP-7 treated sites was 8.3 mm, which is in contrast to a mean height of 3.6 mm in the PRP group ($P = 0.013$). The area of the newly mineralized bone on the sinus floor was larger in the presence of PRP (51.32%) than in the presence of rhBMP-7 (33.12%), however, this difference was not significant ($P = 0.081$) (Table 1).

**Discussion**

Since the first description of local application of PRP produced by a gradient density cell separator [Electro Medics 500R, Medtronics, Minneapolis, MN, USA] to accelerate the maturation of bone transplants in maxillofacial surgery [Marx et al. 1998], many methods have been proposed to produce PRP by using a conventional centrifuge to facilitate its application for implant surgery in clinical practice [Landesberg et al. 2000; Weibrich et al. 2001]. In the present study, we chose a validated method to produce PRP [Roldán et al. in press], which resembles the method of Marx et al. [1998], but is adapted to the handling of smaller volumes of blood according to the animal model. The mean value of the concentration factor of thrombocytes in PRP was 3.5, which is comparable with the factor 3.4 reported by Marx et al. [1998]. Nevertheless, a statistical correlation between the thrombocyte count in whole blood and in PRP was not seen, possibly due to the small sample size ($n = 5$). Moreover, a high variability in the thrombocyte count in the whole blood of the experimental animals was observed [maximum: $620 \times 10^3$ cells/µl and minimum: $173 \times 10^3$ cells/µl]. This is a critical aspect because the application of thrombocytes and the contained growth factors is not standardized. Experiments on local application of recombinant growth factors showed a dose-dependent effect [Noda & Camilliare 1989; Pfeilschifter et al. 1990; Nash et al. 1994; Ripamonti et al. 1997]. The effect of the local application of growth factors also depends on the application site [Fujimoto et al. 1999], age and animal model [Ripamonti et al. 1997]. The effect of TGF-β has been shown to be biphasic depending on the dose; at a high concentration an inhibition of osteoblast proliferation has been seen [Centrella et al. 1994; Fujimoto et al. 1999]. Further investigations have to be undertaken to clarify the interaction of growth factors at higher levels in a PRP model.

In the literature, no data are reported on the influence of PRP on BIC. BMPs, previously shown to be an effective approach to enhance osseointegration of dental implants applied in a mineral or collagen scaffold [Bessho et al. 1999; Terheyden et al. 1999], were chosen as a control group

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**Table 1. Parameters (mean values and standard deviation) of bone formation 6 weeks after sinus augmentation with 3 ml anorganic bovine bone (Bio-Oss®) and primary insertion of a titanium implant (ITI®) combined with 600 µl of PRP (in 15%-vol. autologous bone) or 420 µl of rhBMP-7**

<table>
<thead>
<tr>
<th></th>
<th>Bio-Oss® 15%-vol. autologous bone/PRP</th>
<th>Bio-Oss®/rhBMP-7</th>
<th>P-values BMP vs. PRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone-implant contact (%)</td>
<td>5.76 ± 11.8</td>
<td>45.80 ± 18.58</td>
<td>0.002*</td>
</tr>
<tr>
<td>Area of newly mineralized bone on the sinus floor (%)</td>
<td>51.32 ± 20.83</td>
<td>33.12 ± 13.65</td>
<td>0.081</td>
</tr>
<tr>
<td>Height of the newly mineralized bone in the augmented area (mm)</td>
<td>3.58 ± 3.3</td>
<td>8.35 ± 2.74</td>
<td>0.013*</td>
</tr>
</tbody>
</table>

*Statistically significant difference (t-test).

rhBMP, recombinant human bone morphogenetic protein; PRP, platelet-rich plasma.
in order to evaluate the efficiency of PRP to improve BIC. In the present study, the achieved BIC 6 weeks following PRP application was 5.76% compared with 45.8% in the presence of rhBMP-7. The achieved BIC in the PRP model has to be considered inadequate in a clinical setting and does not show a benefit compared with reported studies on sinus augmentation with Bio-Oss® alone, as shown by Hass et al. [1998], who informed about a BIC of 27.4% 12 weeks after sinus augmentation in sheep. Others reported about a BIC of 63% in beagles [Schlegel et al. 2003] or 38% in miniature pigs [Terheyden et al. 1999] after an observation period of 6 months. Lynch et al. [1991] demonstrated a statistically significant enhancement of the BIC 7 days after the application of rhPDGF und rhIGF-I. This positive effect of growth factors on osseointegration suggests that in the present study the required concentration of growth factors contained in PRP may not have been achieved.

The mean BIC in sites conditioned with rhBMP-7 was 45.8%. Terheyden et al. [1999], using the same experimental model, reported a mean BIC of 80% after 6 months for the rhBMP-7 group. The present study shows the strong effect of BMP at the very beginning after application. In vitro studies by the same authors on Bio-Oss® loaded with rhBMP-7 showed a release of 98% of BMP into simulated body fluid within 24 h [Jepsen et al. 1999]. The evaluation of the effectiveness of BMP, compared with PRP after 6 weeks, is therefore appropriate. An evaluation of the effect of BMP or PRP after 6 or 9 months is not appropriate, because a bone integration of anorganic bone in the absence of bone-stimulating factors is to be expected after that time [Hürzeler et al. 1996; Hass et al. 1998; Valenti et al. 1998].

The area of newly mineralized bone on the sinus floor is expected to be larger in the vicinity of the residual host bone [Quínones et al. 1997]. In the present study, the area of newly mineralized bone on the floor of the sinus was higher in the presence of PRP (51.32%) than under the influence of rhBMP-7 (33.12%), although this difference was not statistically significant. The observed increase in trabecular bone area on bone grafts treated with PRP by Marx et al. [1998] declined from the second to the sixth month after surgery. Schmitz & Hollinger (2001) discussed this work, and extrapolated the curve of the area of the trabecular bone in the bone graft to 1 year and concluded that in the long term there may be no observable advantage in bone density of treated bone grafts with PRP. Fürst et al. [2003] performed sinus elevation procedures in mini-pig using hydroxyapatite for augmentation. PRP was added to the test side; however, no dental implant was inserted. An enhanced bone density was seen on the base of the sinus in the presence of PRP 3 weeks after surgery; at 6 weeks the bone density declined and at 12 weeks there was no difference to the control side [Fürst et al. 2003]. The observed enhancement of the trabecular bone area at the beginning of the observational period could be of no clinical interest in the long term, as it has to be realized that the trabecular bone area will undergo continuous remodeling in response to the mechanic and the endocrine demands.

In the present study, the mean height of newly mineralized bone in the augmented area was 8.3 mm in the presence of rhBMP-7, which corresponded to the total height of the implanted anorganic bovine bone. In the presence of PRP, the achieved value was 3.6 mm. It is expected that the augmentation of the sinus with Bio-Oss® in the absence of bone-stimulating factors has to be integrated into new bone, if it takes 6–9 months [Hürzeler et al. 1996; Hass et al. 1998; Valenti et al. 1998]. The very slow resorption rate of Bio-Oss®, a property of this material that is often criticized [Skoglund et al. 1997], could be of advantage in sinus surgery [Schlegel et al. 2003], because it permits a full bone integration of implanted anorganic bovine bone before the resorption of the scaffold starts, as demonstrated by Hürzeler et al. [1996] and Hass et al. [1998].

The rationale of adding autologous bone to PRP was to supply osteoblasts to support the proposed mitogenic effect of PRP [Weibrich et al. 2002]. As shown in the extra-skeletal model in the rat PRP is not osteoinductive and could not enhance bone formation on Bio-Oss® in skeletal sites [Roldán et al. 2004]. Because of the known osteoinductive effects of BMPs, no autologous bone was grafted into the correspondent sinus.

Autologous bone [15% vol.] collected during the preparation of the implant site was mixed with Bio-Oss® to enhance bone formation in the presence of PRP as it is recommended when Bio-Oss® is applied in the clinical setting [Yıldırım et al. 2001]. In spite of the addition of autologous bone to Bio-Oss® in the PRP model, vital bone could only be seen in the proximity to the sinus walls. In the future, it has to be tested if the addition of more autologous bone can improve the osteogenesis in a PRP model. However, if more bone than 15% vol. has to be applied, it will be necessary to harvest the additional bone-graft from a second donor site. The augmentation of the sinus with Bio-Oss® in the presence of rhBMP-7 was carried out without the addition of autologous bone. Nevertheless, homogeneous bone formation was seen in the whole implanted area.

To our knowledge, this is the first report to compare the effect of rhBMP-7 and PRP in implant surgery. PRP could not improve the osseointegration of dental implants in regenerated sinus bone after an observation time of 6 weeks. Our data support the concept that recombinant BMPs in combination with an appropriate matrix carrier may become clinically effective to improve and accelerate osseointegration of dental implants.

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Résumé

Le but de l'étude présente a été d'évaluer le bénéfice possible du plasma riche en plaquettes (PRP) dans le greffage sinusal comparé à la protéine-7 morpho-génétique osseuse recombinante (rhBMP-7). Un épaississement du sinus bilatéral a été effectué avec de l'os bovin anorganique et l'insertion simultanée d'un implant vis en titane chez cinq mini-porcs. Six cent microlitres de PRP et 15% vol d'os autogène, qui avait été prélevé dans une trappe durant la préparation du site implantateur receveur, ont été placés dans le sinus droit et 420 microlitres de rhBMP-7 dans le sinus gauche. Un manqueq séquentiel polychôme a ensuite été effectué. Les animaux ont été euthanasiés six semaines après la chirurgie. Des coupes épaisseurs non-décalkifiées ont été évaluées par radiographies, histométrie radiographique et sous lumière à fluorescence. Le contact os-implant moyen en utilisant rhBMP-7 était de 45,8% et 5,7% sous PRP (p = 0,002). La hauteur moyenne de l'os...
mineralized novo dans la partie épaisse rhBMP-7 montait à 8,3 mm contre 3,6 mm pour le PRP (0,013). En utilisant PRP, l’aire moyenne de l’os néoréformé était augmentée [51,3 %] comparée à rhBMP-7 [33,1 %], cette différence n’étant cependant pas significative (p = 0,081). En conclusion, sous des conditions expérimentales sélectionnées, l’utilisation de rhBMP-7 apporte des avantages supérieurs en ce qui concerne l’ostéointégration des implants dentaires et la hauteur de l’os néoréformé comparé à l’utilisation du PRP.

Zusammenfassung

Sinusbodenelevation mit gleichzeitiger Platzierung von dentalen Implantaten mit plättchenreichem Plasma oder rekombiniertem menschlichem knochennorphogenetischem Protein

Das Ziel der vorliegenden Studie war, dem möglichen positiven Effekt von plättchenreichem Plasma (PRP) im Vergleich zu rekombiniertem menschlichem knochennorphogenetischem Protein (rhBMP-7) bei der Sinusbodenelevation zu untersuchen. Zu diesem Zweck wurde bei fünf Minipigs eine bilaterale Sinusbodenelevation mit anorganischem bovinem Knochen und gleichzeitig die Implantation eines Schraubenimplantats durchgeführt. Sechsundvierzhundert µl PRP und 15%-vol. autologer Knochen, welcher bei der Präparation des Implantats geschnitten wurde, wurden im rechten Sinus dazu gefüllt und 420 µl rhBMP-7 wurden in den linken Sinus eingebracht. Es wurde eine polychromatische Sequenzmarkierung durchgeführt. Sechs Wochen nach dem Eingriff optierte man die Tiere. Die nicht entkalkten Schliffpräparate wurden mittels Mikrotomographie, digitalisierter Histomorphometrie und unter fluoreszierendem Licht untersucht. Der mittlere Knochen-Implantat-Kontakt betrug mit rhBMP-7 45,8% und mit PRP 5,7% (P = 0,001). Die mittlere Höhe an neu gebildetem mineralisiertem Knochen im Augmentatt erreichte 8,3 mm bei rhBMP-7 und 3,6 mm bei PRP (P = 0,001). Mit PRP war die Fläche an neu gebildetem mineralisiertem Knochen größer [51,3 %] als mit rhBMP-7 [33,1 %], jedoch war dieser Unterschied nicht statistisch signifikant (P = 0,081). Es wird die Schlussfolgerung gezogen, dass unter den ausgewählten experimentellen Bedingungen die Verwendung von rhBMP-7 im Vergleich zu plättchenreichem Plasma zu besseren Resultaten bezüglich Osseointegration von Dentalimplantat und der Höhe von neuem Knochen führt.

Resumen

La intención del presente estudio fue evaluar el posible beneficio del plasma rico en plaquetas (PRP) en el injerto de seno en comparación con la proteína-7 morfogenetica ósea humana recombinante (rhBMP-7). Para este propósito, llevamos a cabo aumento del seno bilateralmente con hueso bovino anorgánico e inyección simultánea de un implante rosado en cinco cerdos miniatura. Se añadieron 600 µl de PRP y 15%-vol. de hueso autólogo, que fue recolocado usando una trampa durante la preparación del lugar receptor del implante, al seno derecho y 420 µl de rhBMP-7 al seno izquierdo. Se llevó a cabo un marcado polícromo secuencial. Los animales se sacrificaron seis semanas tras la cirugía. Se evaluaron las secciones descalcificadas microradiográficamente, histomorfométricamente y bajo luz fluorescente. El contacto hueso a implante medio usando rhBMP-7 fue 45,8% y 5,7% bajo PRP (P = 0,001). La altura media del hueso neoformado en el área aumentada usada rhBMP-7 llegó a 8,3 mm frente a 3,6 mm bajo PRP (P = 0,001). Usando el PRP, el área media de hueso neoformado aumentó [51,3 %] en comparación con rhBMP-7 [33,1 %], sin embargo esta diferencia no fue estadísticamente significativa (P = 0,081). En conclusión, bajo las condiciones experimentales seleccionadas, el uso de rhBMP-7 condujo a unos resultados superiores respecto a la osteointegración de implantes dentales y a la altura del nuevo hueso en comparación con el uso de plasma rico en plaquetas.

Referencias


