Secure and effective stabilization of different sized autogenous bone grafts

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Aim

A secure and solid fixation of the bone graft is an important criteria of success in augmentation procedures. Titanium screws are frequently oversized to fix small dimensioned bone grafts and may osseointegrate, thus leading to complications during screw removal. To solve these problems the new Microscrew® system was developed and investigated in this retrospective clinical study.

Materials and Methods

A total of 318 patients were treated in 2009 with autogenous bone grafting, according to the biological concept, in different indications from small to complex 3D bone defects. All in all, 486 autogenous bone grafts were stabilized with 923 Microscrews®, special self-tapping screws with a narrow diameter of 1 mm, made of medical stainless steel. Moreover, 287 implants were placed simultaneously and 449 implants were inserted with a delayed procedure after 3-4 months. All implants were loaded 3-4 months later.

Results

All bone grafts achieved a good stability by the use of the Microscrews®. An average of two Microscrews® was necessary to fix the bone grafts of different dimensions. Most of the grafted bone healed as expected and only some few complications occurred, such as infections (0.2%), limited graft exposure (1.2%), screw head exposure (5.3%), incomplete graft regeneration (1.8%) and bone resorption of more than 15% (2.4%). All implants could be placed according to the treatment plan. There was no graft failure, no soft tissue irritation, no screw fracture, no allergy, no screw aspiration, no metallosis and none osseointegration of the screw. After a follow up of two years all the implants were still functioning without any osseointegration disturbance.

Conclusions

The present study shows that the Microscrew® system is suitable for the stabilization of different sized bone grafts. Some drawbacks of titanium screws could be solved. The healing of the grafted bone and the surrounding soft tissue as well as the inserted implants occurred without any major disturbance.

Key words:

Graft stabilization, stainless steel screws, tissue healing.

Introduction

Patients with early loss of teeth frequently show localized or generalized bone defects of the alveolar ridge in the maxilla as well as in the mandible. Those defects may be a result of atrophy, dental traumata, accidents, pathologic resorption (imflammation, cyst formation), periodontal disease and previous surgeries (4). Missing teeth with important bone loss are associated with compromised mastication, swallowing, and speech functions as well as psychological conditions, thus leading to functional and aesthetic impairments which reduce the quality of life of the patient (6, 14, 20).

Replacement of the lost dentition by implant supported restorations offers the patient a predictable way to oral and thus social rehabilitation. Implant placement requires a sufficient bone volume, and in many cases it is necessary to increase the volume of the alveolar crest, both in width and height, due to the lack of bone, in order to obtain predictable and esthetic results as well as long term stability (2, 11).

It is possible to reconstruct the lost structure of hard and soft tissues with different surgical grafting techniques using autogenous, allogeneic or xenogeneic bone as well as alloplastic materials (18). Overall autologous bone has proved to be superior than other materials and still represents the gold standard in grafting procedures (8, 9, 13). A very important factor for successful autogenous bone augmentation is a good and solid fixation of the grafted bone to the recipient site. Most of the screws used to fix bone grafts are made of titanium and have an external screw diameter between 1.3 and 2 mm in the lengths from 6 to 18 mm (5, 19). The screw design is different for each manufacturer, but it can be broadly classified in self-drilling, self-tapped, pretapped and resorbable screws [5,13,16,19]. Screws with a diameter of 1.3 mm (the minimum length to prevent fractures) and higher are mostly oversized for the fixation of small bone grafts. There is the risk of fracturing the graft with the screw as well as injuring the simultaneously placed implant or the roots of the neighboring teeth. On the other hand, titanium screws with a diameter smaller than 1.5 mm may fracture (Fig. 1) or get damaged during the removal of the screw, and the titanium they are made of may osseointegrate (13).

Screws made from an alloy of manganese-chromium-Cobalt-molybdenum (medical stainless steel) show better mechanical stability also in a small dimension. These screws were very popular in the 70s and 80s (Vironium, Vitallium, etc) in the traumatologic and orthopaedic surgery. With a deeper knowledge on osseointegration, they were later replaced by titanium. with the goal to leave them in the body after fracture healing. But in case of bone graft stabilization there is no interest with titanium because the screws have to be removed very often during implant placement.

For this indication the new Microscrew® (Stoma, Emmingen-Liptingen, Germany) made of medical stainless steel were developed in small diameter of 1 and 1.2 mm for stabilization of bone graft with different sizes.

We present here the results of a retrospective clinical study on patients treated with this screw in the year 2009. The aim of this retrospective study is to investigate and to evaluate the stabilization of autogenous bone grafs with the Microscrew® System. Different bone grafting techniques, from the minimal invasive small augmentation to 3D reconstruction of vertical defects, were performed. Analysed criteria were handling of the Microscrew® System, safety device, stability, biological and clinical reaction of the screws, results of the bone grafting and removability of the screws as well as long term stability with a 2 years follow up.

FIG. 1 Fractured titanium screw with 1.2 mm diameter during screw removal.

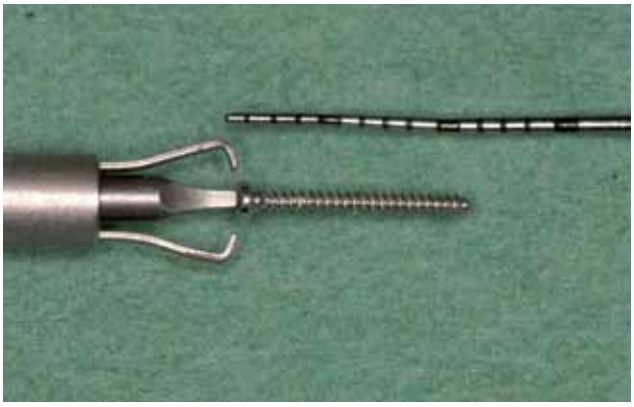

FIG. 2 Microscrew® with 1 mm diameter and the special screw driver.

Materials and methods

The retrospective study evaluates all patients who were treated in the year 2009 with bone grafting procedures, according to the biological concept of bone grafting (8, 9), using the MicroSaw (7) and the new Microscrew® System. A total of 318 patients (108 male and 210 female) aged from 17 to 88 years underwent autogenous bone graft in different indications starting with small periimplant exposed threads to complex 3D bone defects. In this period a total of 443 bone blocks, mostly harvested with the MicroSaw from the retromolar area of the mandible, and 43 cores, harvested with a trephine bur from the implant recipient site, were grafted and stabilized with a total number of 923 Microscrews®. These special screws are self-tapping and have an external diameter of 1 and 1.2 mm. The main screw is 1 mm; the 1.2 mm is the emergency screw. The screw length is available from 4 to 16 mm. A special screwdriver with a safety device is securing handling, preventing the uncontrolled looseness of the very small screw (Fig. 2). The screws are made of a special medical stainless steel alloy, with main components manganese, chromium, cobalt

FIG. 3 Implant insertion inside the contours: about half of the buccal bone is missing.

FIG. 4 Reconstruction of the missing bone with the core harvested from the implant bed: a 1 mm diameter and 10 mm length Microscrew® is pressing the bone core on the implant surface giving an excellent stability.

FIG. 5 Occlusal view demonstrating the thickness of the new buccal bone.

FIG. 6 Clinical appearance after the restoration of the implants.

FIG. 7 Stabilization of a mini bone block with a Microscrew®.

and molybdenum. This gives the small diameter (1 mm) screws an excellent mechanical stability and the possibility to fix bone grafts of any sizes. Moreover, owing to the fact that the screws are not made of titanium, there is no osseointegration and so they can be removed very easily with no risk of screw fracture or wearing out the screw head. The small dimensioned screw head is not causing any soft tissue irritation and has less risk of screw exposure during the healing period.

In the present study the screws were used to stabilize 43 bone cores in combination with simultaneous implant placement (Fig. 3-6) to reconstruct 24 minor peri-implant bone defects in the maxilla and 19 in the mandible.

The screws were used for 307 lateral grafts with bone blocks (218 in the maxilla, 89 in the mandible) and 124 vertical grafts and 3D reconstructions (78 in the maxilla and 46 in the mandible). In 12 cases one screw was used to fix a replanted half bone block in its original site in the retromolar area. A total of 287 implants were placed simultaneously (Fig. 7) and 449 Implants were placed after a healing period of the grafted bone of 3-4 months. The implants were loaded 3-4 months later.

Most of the Microscrews® were removed at re-entry during implantation, or second stage surgery. In some rare cases the screws were left in the site eg. in the retromolar area or in cases where there was no need to raise a flap.

Results

In the year 2009 a total number of 486 autogenous bone grafting procedures were performed in 318 patients according to the biological concept of bone grafting. A total of 923 Microscrews® were placed in order to fix and stabilize the grafted bone. An average of 2 Microscrews® were necessary to fix the bone blocks with different dimensions or to stabilize the cores. The smallest block fixed with the Microscrew® was 12 mm^2. All bone blocks and cores had good stability thanks to the use of the screws. No bone blocks nor cores were damaged during the fixation procedure.

Most of the grafted bone healed as expected, so that all implants could be placed as it was planned before (Fig. 8-14). In only one case (0.2%) a primary infection

process occurred with partial loss of the graft. No infection nor negative influences of the screws on the wound healing were observed. In no case an allergy against the material occurred. From the other site few complications occurred related to the bone grafting procedure: limited graft exposure due to partial flap necrosis or dehiscence was observed in 5 cases (1.2%). After primary treatment with local desinfection (chlorhexidine rinsing 0.2% and chlorhexidine gel 0.1%), the exposed and infected bone areas were reduced, desinfected with antimicrobial-photodynamic therapy (3) and the wound was closed in double layer.

FIG. 8 3D Bone reconstruction of the anterior part of the left maxilla: 2 bone blocks are stabilized with 3 screws. On the right maxilla the 3D bone reconstruction was performed with simultaneous implant placement.

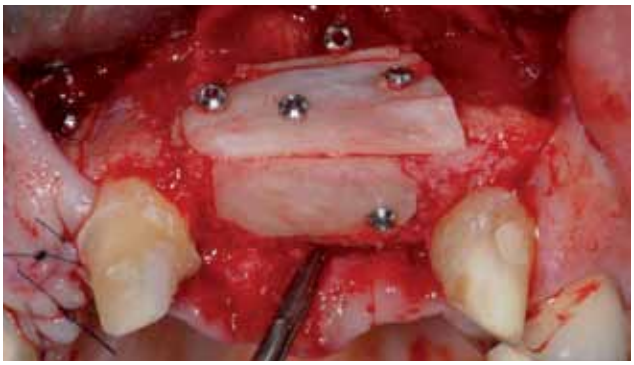

FIG. 9 After filling the space with particulate bone a third bone block is screwed on the occlusal side.

FIG. 10 The clinical result three and a half months postoperatively: good healing of the grafted bone without any negative reaction around the screws.

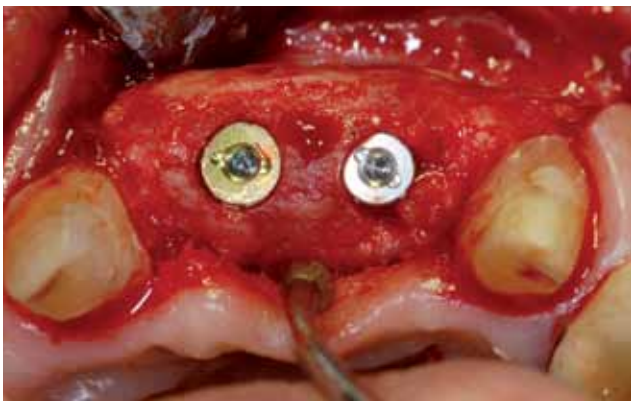

FIG. 11 Two implants were placed in the grafted and regenerated area in optimal conditions.

FIG. 12 Clinical appearance of the restored implants 2 years postoperatively.

FIG. 13 Radiograph of the right anterior area 2 years postoperatively: good osseointegration of the implants. The screw was left in the bone since it caused no disturbance.

FIG. 14 Radiograph of the left grafted area of the maxilla 2 years postoperatively demonstrates the stability of the grafted bone and the good osseointegration of the implants.

Premature exposure of the screw head (mostly 8 weeks after surgery) occurred in 26 cases (5,3%) and had mostly no influence to the hard and soft tissue healing. There were no irritation of the mucosa and in just in 7 cases a little resorption of the bone was found, around the screw up to the second winding. Exposed screws were removed flapless without doing any surgery or sutures.
Incomplete regeneration of the grafted bone with soft tissue migration in the grafted area was observed in 9 cases (1.8%) and bone resorption of more than 15% occurred in 12 patients (2.4%). A limited re-augmentation was performed in these cases during implant placement.
Overall, neither damage of the screws nor of the surrounding tissues were observed: no screw fracture, no wearing of any screw heads, no screw aspiration, no metallosis and no osseointegration occurred, so that all screws were easily removed.
Each Microscrew® ensured at any time a good stability of the grafted bone and could always be removed as easy as they were placed. All Microscrews® that were left in the site showed a good and uneventful healing in every case so that there was no urgent need to remove the screw.
After a follow up of two years all the inserted implants were still functioning without any osseointegration disturbance.

Discussion and conclusion

One of the most important factors of bone grafting procedures is the good stability of the graft, which is difficult to achieve with standard titanium screws in grafts of small dimension.
The results of this retrospective study confirmed that the use of small diameter (1 mm) screws made of medical stainless steel can be a good alternative for the fixation and stabilization of different sized bone grafts. Bone blocks with a length from 5 to 30 mm as well as small bone cores with 2 mm diameter showed a good fixation and stability with the 1 mm screws and the grafting procedure showed similar good results as with titanium screws. In some cases there is not enough space on the recipient site between the implant and the neighboring tooth when cores or small blocks are grafted with simultaneous implant insertion in a limited area, as for example in a single tooth implantation. Screws made of titanium or resorbable screws made of PLLA are mostly 1.5 mm or 2 mm and higher in diameter (13): with these diameters the screws are oversized and could not be used in these indications due to the risk of fracturing the graft, or injuring anatomical structures or neighboring teeth. In such situation the 1 mm diameter screw can simplify these difficulties and give more security in prevention of complications (Fig. 7). So far no foreign body reaction was observed.
In the literature there are not many clinical studies or evaluations of dental osteosynthesis screws in autogenous bone augmentation. Fracture of titanium screws is reported, especially at the time of screw removal if the screws were osseointegrated (13). Microscrews® are not made of titanium but of medical stainless steel and for this reason the risk of screw fracture is highly minimized. In the present study no screw fracture was observed. There were no osseointegration of the screws and the screw removal was as easy as the placement (Fig. 15, 16).
It is mentioned as a drawback that there is a need of a second surgery for screw removal (13), but this is not a big disadvantage in implant surgery, because usually after augmentation and implantation there is another surgical intervention where screws can be removed during implantation or second stage surgery. So there is no discomfort to the patient and no extra intervention beside those planned before. Beside that, Microscrews® have no urgent need to be removed and could be left in the site, as it happened in some cases. No bone overgrow on the Microscrews® was observed at all as it is reported in the literature, and this makes the removal of the screw more difficult (13). This is possible thanks to the alloy used and the design of the screw head, with a square drive which is not flat.
The Microscrews® are self-tapped screws and come along with a corresponding drill bur with marks for the depth. The fixation of the graft was achieved in each case and showed excellent stability at any time until the healing of the graft and the removal of the screws. A special screwdriver mounted on contra-angle is helpful in areas of difficult access for optimal stabilization of the Microscrew® (Fig. 17, 18). The literature reports of the fixation measured by pullout strength showed that there is no difference between self-tapped and pretapped screws of equal diameter: both showed similar values even after insertion and removal in the same hole for several times (5). Similar results are reported by Koranyi et al. and Schatzker et al. (10, 15). Other studies showed a greater holding strength

FIG. 15 3D reconstruction with tunnel approach: The 2 bone blocks were stabilized with 5 Microscrews®.

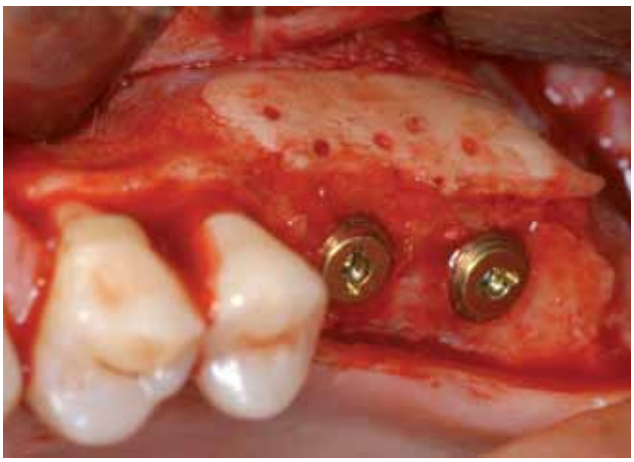

FIG. 16 Clinical appearance 4 months postoperatively: 2 implants inserted in the grafted/regenerated bone.

FIG. 17 Screw driver mounted on contra angle allows the insertion of the screw in difficult situation.

FIG. 18 3D reconstruction on the posterior mandible with simultaneous implant insertion.

in the thin maxillo-facial bone for self-tapped screws than for pretapped screws. And therefore self-tapped screws are more commonly used in thin bone such as that found in the maxilla (1, 12, 19). So there are no advantages with the pretapped screws, but some drawbacks such as an additional step of tapping the hole, more instruments and complex handling.

Another important feature of the Microscrew® System is the special screwdriver with a safety device. The Microscrews® are inserted at the top of the screwdriver with the clamping device. In this way the screw is fixed to the screwdriver, thus preventing the screw dropping down to the ground or the patient´s mouth which could be aspirated or swallowed up by the patient. This complication never happened in the presented study. Aspiration and ingestion of teeth and dental instruments is a well known complication which can happen during any treatment (17).

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