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Endoscopic Interventions in Oral Implantology - A Report of 5 Years Clinical Experience

Intervenciones Endoscópicas en Implantología Oral - Reporte de 5 Años de Experiencia Clínica

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ABSTRACT: Minimal invasive treatment is an important goal of current implant surgical procedures. The aim of the article is to present data on endoscopic procedures in implant surgery to give an overview on the current clinical experience in this field. Endoscopy as part of surgical procedures in implantology consists of the use of rigid endoscopes of 1.9 to 2.7 mm diameter with a variety of support shafts to obtain constant working distance. An irrigation system cleans the optical window. Endoscopy has been applied in the following manner: Internal osteoscopy to inspect bone cavities, external osteoscopy to viszualize bone surfaces, alveoloscopy for diagnosis of alveolar defects and periodontoscopy to visualize peri-implant structures. During the first 5 years of application between 1999 and 2004 the following interventions were carried out: 263 alveoloscopies in 89 patients, 1568 internal osteoscopies in 595 patients, 429 sulcus periodontoscopies in 131 patients and 282 external osteoscopies (subantroscopies and external tunneling) in 236 patients. Method- related possible complications as infection, dry socket, aspiration or intolerance of the method have not been observed. Using various types of endoscopy, the main pathological findings were: Alveolar bone defects, granuloma, foreign bodies, insufficient bone structure, perforation, alveolar bone fenestration, periimplantitis, periimplant bone defects, misfit or damage of implant suprastructures, incompletely regenerated bone structure after augmentation. Endoscopic findings influenced in the surgical procedure in the following cases: Removal of soft tissue, removal of foreign material, decision on augmentation, selection of implant diameter, mode of implant insertion , selection of implant type , mode of implant loading. Endoscopy has become a valuable tool to assist implant surgery, to ensure quality of bone, to check bone structure in vivo, to assist minimal invasive augmentation and to verify the fit of meso- and suprastructures in implant treatment. The first five years of intensive use of support and support immersion endoscopy did not show any evidence of method - related morbidity and contributes valuable data for minimal invasive implant placement

KEY WORDS: endoscopy, dental implants, alveoloscopy, osteoscopy, periodontoscopy.

INTRODUCTION

According to Juodsbalys *et al.* (2008) endoscopes are used in dentistry for endodontic applications, for evaluation of conventional sinus floor augmentation and for the subantroscopical laterobasal sinus floor augmentation. In the field of maxillofacial surgery, endoscopy primarily was used to visualize the augmentation procedure during sinus floor augmentation (Nkenke *et al*., 2002; Baumann & Ewers, 1999). A clinical study concerning minimal invasive sinus floor elevation has shown that this technique with endoscopic control leads to predictable results (Engelke *et al*., 2003). In the past, endoscopy has not been used for assessment of implant cavities because the endoscope visualization was hindered and commonly suspended by rapid optic pollution following bleeding into the cavity. Facing a similar methodical problem, perioscopy was developed with an irrigation system to view the periodontal sulcus after root scaling (Ozawa *et al*., 1999; Stambaugh *et al*., 2002). As an important limitation, perioscopy revealed to have a limited image quality due to the small dimension of the fiberscope used and therefore it was not suitable for general use in implantology.

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To overcome the limitations of conventional viewing of dental structures in small bone cavities, a support immersion technique (SIE) was developed (Engelke, 2002). SIE can be a compliment method to radiographic examinations of implant sockets (Juodsbalys *et al*.). Support immersion endoscopy is principally based on endoscope application with support and possible continuous irrigation. This permits an interface-free observation of bone structures in a liquid media. SIE allows magnification and digital recording of the field.

Rigid endoscopes with especially designed support immersion shafts have been used in various fields of dentistry (Engelke & Capobianco, 2004b). In oral implantology, it can be used in the following procedures:

* internal osteoscopy to observe freshly prepared implant cavities.
* alveoloscopy to view extraction sites before and during immediate implant placement.
* external osteoscopy to assist augmentative procedures when using closed tunnel techniques.
* perioscopy during exposure of implants to check the fit of healing abutments and impression posts.

In this report the use of endoscopic procedures in clinical routine of peri-implant surgery shall be described to shed light on the feasibility of endoscopes.

MATERIAL AND METHOD

For all endoscopic procedures, the following components were used (all provided by Karl Storz, Tuttlingen, Germany):

1. Storz-Hopkins 1.9 and 2.7 mm, 30º and 70º endoscopes.
2. Support and irrigation shafts.
3. Device for continuous laminar irrigation flow.

The endoscopes were linked up with a Storz 487 B examination unit and a video tape recorder (VHS video recorder, Sony, Köln, Germany). A xenon 300W light fountain with 6000 K capacity served as light source. The endoscopic aquipment is shown in Figs. 1a, 1b.

1. Alveoloscopy. Alveoloscopy is performed using SIE - technique with 1.9 mm, 30º and 70º rigid endoscopes. The concept of alveoloascopy is displayed in Fig. 2a. Observation of the alveolus comprises the examination of alveolar walls after extraction, diagnosis of wall defects and structural anomalies, examination of the apical region, identification of granuloma or foreign bodies after endodontic treatment and inspection for root fragments. In Fig. 2a, al periodontal ligament with a red of capillary vessels is displayed (above). Bleeding of the bone vessels can be observed immediately after extraction in post-extraction sites.

2. Internal osteoscopy. Internal osteoscopy follows the principle of alveoloscopy with the intention to visualize artificial instead of natural alveolar bone cavities. It is performed using SIE - technique with 1.9 mm, 30 degree and 70 degree rigid endoscopes. Internal osteoscopy is mainly used for in situ examination of implant cavities. The endoscope is positioned and supported on the osseous wall of the cavity after creation of at least a 2.5 mm drill hole. A survey of the cavity is obtained placing the endoscope at the alveolar limit, detail view can be taken when guiding the endoscope tip along the cavity walls. The aim of the examination is the determination of bone structure and the visualisation of critical aspects of the cavity i.e. perforations, fenestrations, foreign bodies, detection of soft tissue, and to exclude failures of cavity preparation (neighbouring teeth, nerve canal or sinus membrane). Osteoscopic findings of artificial bone cavities are displayed in Fig. 3a – 3d: A normal implant cavity with bone particles at the bottom and type 3 bone structure is shown in Fig. 3a, Fig. 3b shows fatty bone marrow. The stepped implant cavity preparation in predominantly cortical bone is shown in Fig. 3c, a fracture of the alveolar bone following bone splitting in the anterior maxilla is shown in Fig. 3d.

3. External osteoscopy. The concept of external osteoscopy is displayed in Fig. 2 b. External osteoscopy is performed along the outer surface of the alveolar bone via subperiosteal soft tissue tunnels. It is carried out using the support shaft (30° 2.7 mm endoscope) with or without irrigation. External osteoscopy serves to control tunnel preparations along the alveolar crest (para and pericrestal tunnel technique) Subantroscopy is part of the minimal invasive sinus floor augmentation and allows to observe a laterobasal tunnel created through a keyhole approach. It also can be defined as a subclass of external osteoscopy.

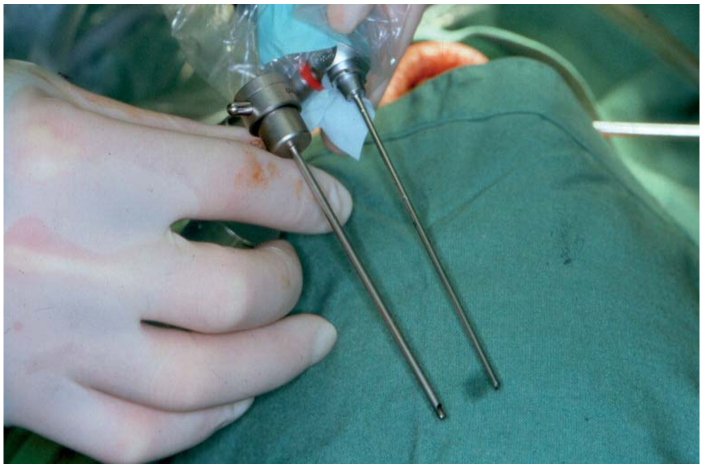


Fig. 1a. Odontoscope with steril cover ready to use.

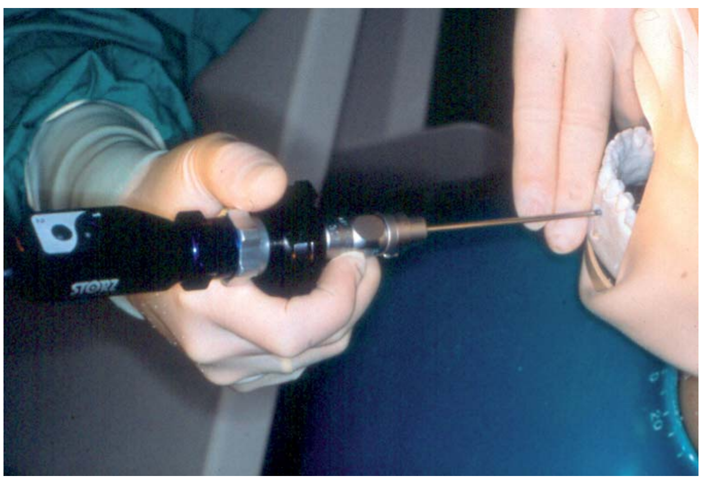


Fig. 1b. Odontoscope in use at phantome modell

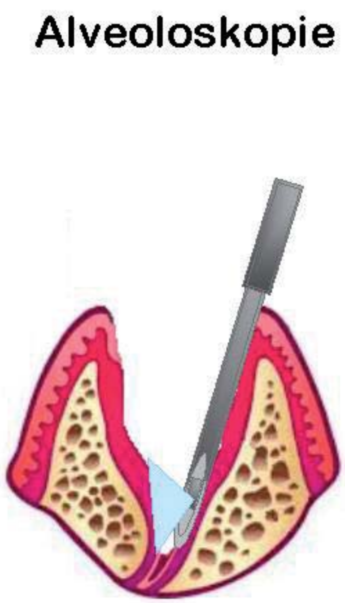
4. Perioscopy. Periocopy (using SIE - technique with 1.9 mm 30° and 70° rigid endoscopes) is displaye in Fig. 2c. In the context of implant surgery it allows to observe details of cervical bone - implant contact during the minimal invasive exposure of the implant and as technique for control of the fit of cover screws and implant abutments. Additionally it can be applied during minimalinvasive treatment of periimplant defects (Sennhenn-Kirchner *et al.,* 2004).

RESULTS

From May 1999 to 2004 at the Dept of oral Surgery at Göttingen university hospital, a total of 2542 endoscopic interventions in conjunction with dental implants were carried out in 1047 patients.

Alveoloscopy. Was carried in 89 patients after 263 extractions, 52 patients were female (mean age 45, min. 17 and max. 89) and 37 male (mean age 48, min. 22 and max. 72). Seventeen implants (titanium screw implants) were placed in 11 patients as immediately implantation, in 6 females (min. 17 and max. 68) and 5 males (min. 48 and max. 72). The following procedures were supported: Diagnostics to identify the implant cavity within the alveolous, endoscopically assisted removal of foreign bodies, removal of root fragments and endoscopically assisted augmentation of alveolar defects. No intraoperative complications during the application of the procedure was observed, no infection occurred. 127 cervical defects of the alveolous were observed , 7 fenestrations, 8 root fragments, 17 implant cavities deviations (alveoloscopy changed drilling location within the cavity), 18 removals of foreign bodies (for example root canal filling materials).

Internal Osteoscopy. Was carried out in 595 patients, 297 female (mean age 54, min 17 and max 89) and 298 male (mean age 56, min 10 and max 87) with the placement of 1568 titanium screw implants (10-18 mm length, 3.25 - 4.5 mm diameter). The following pathologic findings were obteined: 5 Basal perforations, 34 lateral fenestrations, 2 lingual perforations, 21 intended fractures of the cavity wall after bone splitting, 32 exposures of the sinus membranes during internal sinuslifts, 1 exposure of the alveolar nerve, 61 debris in cavity, 7 foreign bodies. Bleeding of the cavity impeded the observation of the wall structure in 20 cases. Forty-fives implant cavities with regenerated bone after TCP augmentation were examined showing remnants of augmentation material. Bone- mapping also was supported endoscopically with additional use of the implant documentation program IMPLAN. No complications of the endoscopical procedure were observed, occasionally anaesthesia hat to be intensified during surgery as consequence of the irrigation of the cavities. In 39 patients (13 female (mean age 54, min. 30 and max. 73) and 26 male (mean age 58, min 21 and max 87) explantation procedures were carried out with internal osteoscopy. Endoscopy allowed the observation of interface structure of osseointegrated implants after removal of implants. Fig. 3 a-c represents clinical examples of implant cavities examined with internal osteoscopy.



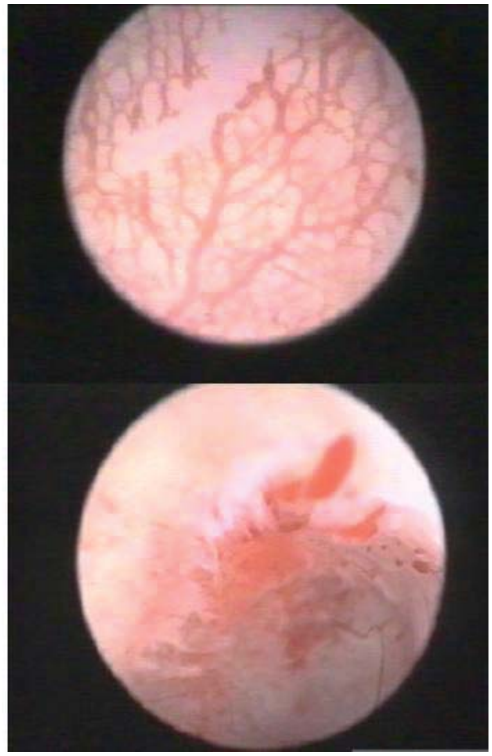


Fig. 2a. Odontoscopic procedures in oral implantology.

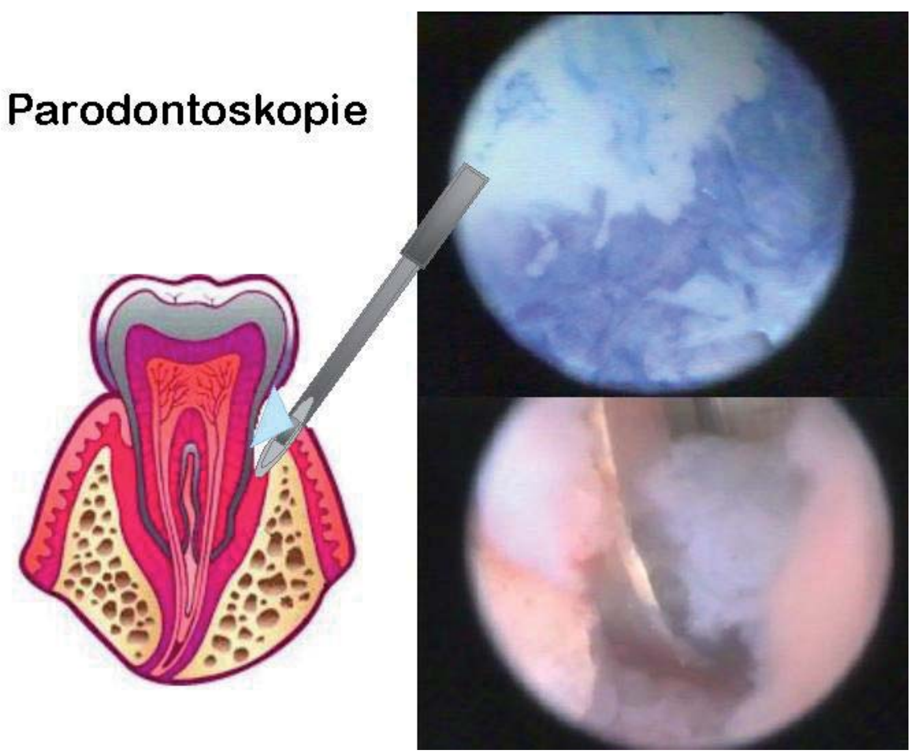
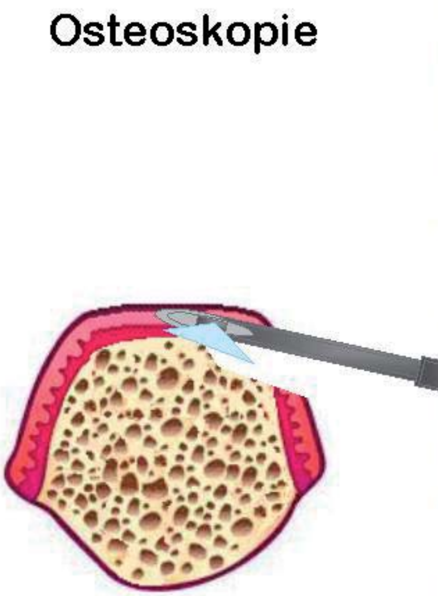


Fig.2b. Alveoloscopy: alveolar margin with periodontal tissue.



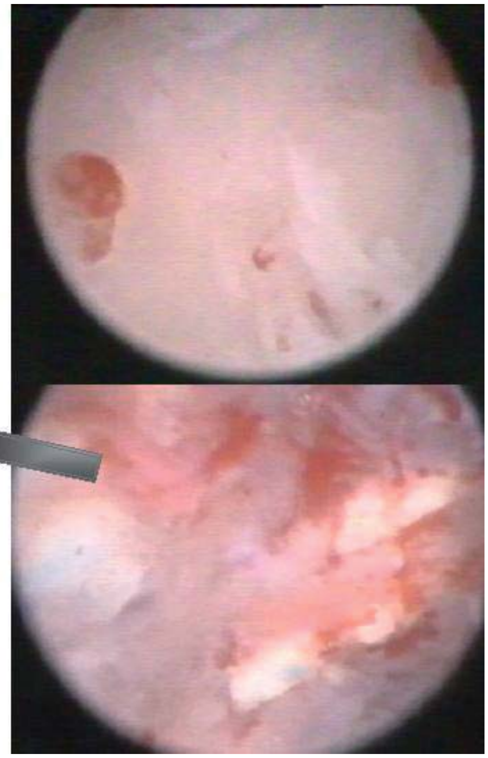


Fig.2c. osteoscopy: bone marrow

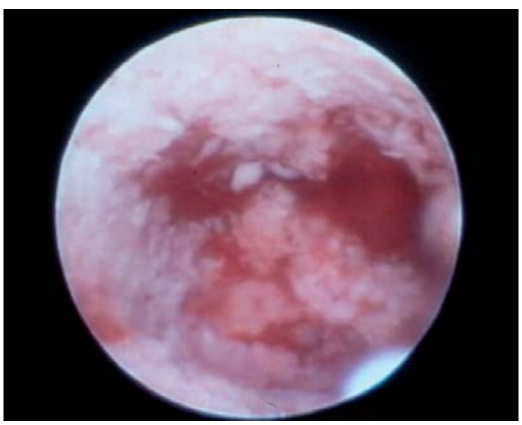


Fig.3a. Internal Osteoscopy: implant cavity containig bone particles .

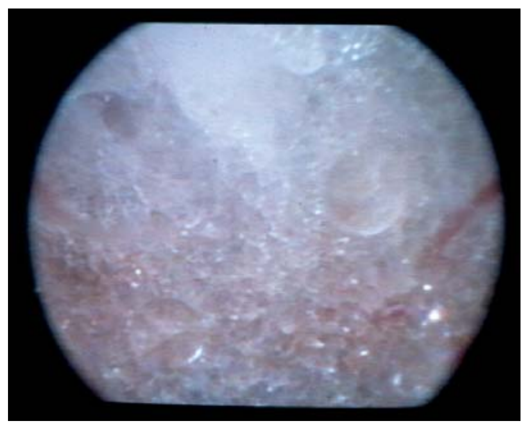


Fig. 3b. Atrophic fatty bone marrow.

Fig.3c. Stepped preparation of a bone cavity for Friadent implant.

Fig.3d. Fracture of an anterior maxillary implant site after bone splitting.

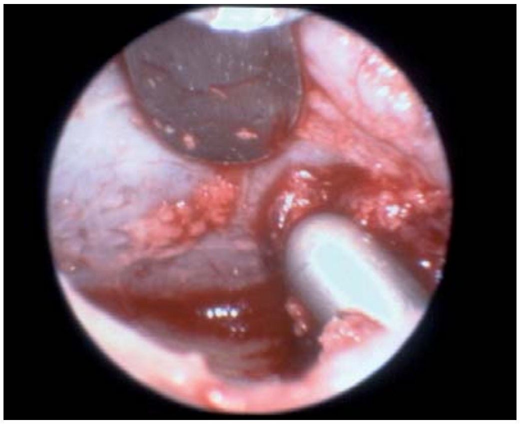


Fig.4a. External osteoscopy: condensation of an implant cavity into the subantral space.

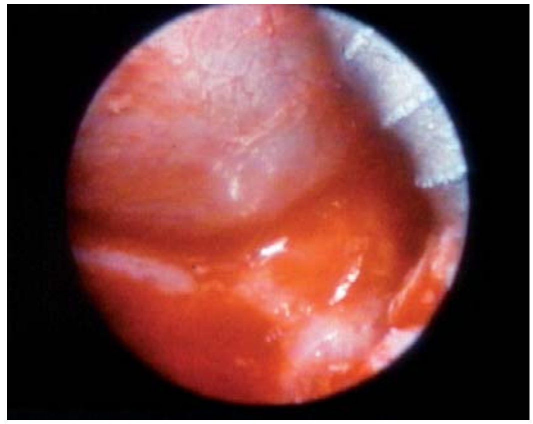


Fig.4b. subantroscopy with ITI implant placed

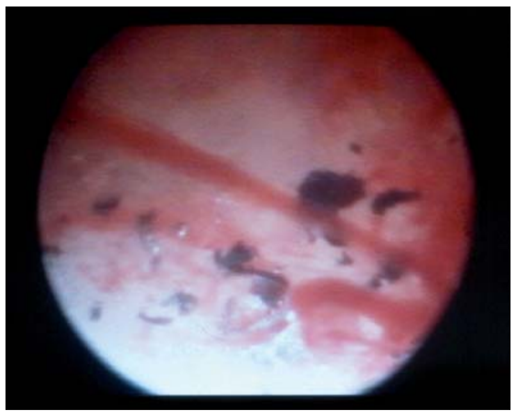


Fig.4c. Foreign bodies at external bone surface.

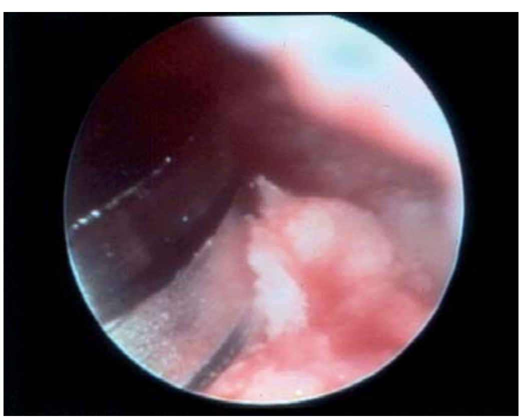


Fig.5a. Sulcus perioscopy: Bone particles in subperiostal peri-implant space

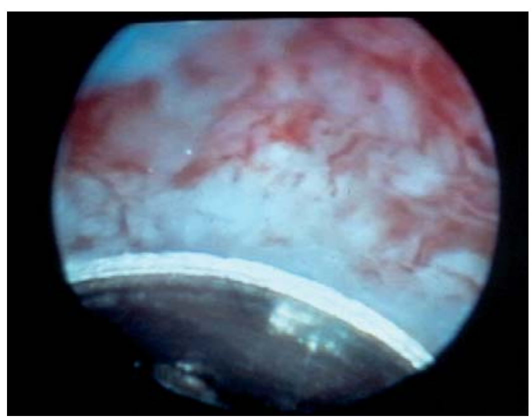


Fig.5b. Tissue surrounding Semados implants after osseintegration period.

External Osteoscopy (observation of epi-osseal artificial spaces) was carried out in 236 patients (102 female (mean age 53, min. 17 and max. 71) and 130 male (mean age 58, min. 21 and max. 78).

External para – and pericrestal tunnel augmentation procedures were performed in 22 cases (12 female (mean age 53, min. 34 and max. 63) and 10 male (mean age 59, min. 46 and max. 70). External osteoscopy served as diagnostic instrument as well as surgical aid for location of the implant site in the regenerative space, location of anatomic problem zones, control of defects and assessment of bone quality. There were 5 cases of perforation of the oral mucoperiostium detected by external osteoscopy. In all cases implant position, alignment of the implant augmentation material were controlled.

Subantroscopy (external osteoscopy of the subantral space) was carried out in 214 patients in 260 subantroscopic laterobasal sinusfloor augmentation SALSA interventions (91 female (mean age 54, min. 17 and max. 71) and 123 male (mean age 58, min. 21 and max. 78). In 42 cases perforations of the sinus membrane were detected and treated subsequently.

Subantroscopy furthermore was used as assistance for augmentation and reinforcement of the sinus membrane during tunnelling procedures with reabsorbable GTR membranes for complication management. Examples of external osteoscopy are displayed in Fig. 4a – c.

Perioscopy. Was carried out in 131 patients (71 female (mean age 56, min. 11 and max. 89) and 60 male (mean age 60, min. 23 and max. 87), in conjunction with 429 implants. Pathologic findings were: Insufficient vestibular bone attachment, unintended growth of bone on the cover screw, misfit of healing abutments due to soft tissue interposition, inflammation of periimplant tissues, gap between implant and the surrounding bone, mobility of implant and foreign bodies. Examples of perioscopy are displayed in Fig. 5a and 5b.

DISCUSSION

The use of endoscopy in oral implantology primarily has been focussed on the control of augmentative surgery of the maxillary sinus (Engelke et al.). Based on the use of endoscopes for maxillary sinus surgery, increasingly the application of optical systems has been expanded. Contact endoscopy served as a method to determine implant micromovement in vitro (Engelke *et al.*, 2004a) and in vivo (Engelke & Capobianco, 2004a) and may provide valuable information about the stability of immediate loaded implants as well as implants after osseointegration in the future. The inauguration of the support immersion technique (Engelke) was the basis for increased use of endoscopy in various field of implantology due to the fact that spoil of the optical window formerly was the most critical aspect of intraoral use of endoscopes. In periodontology Ozawa et al., and later Stambaugh (2002) also reported on fiberscopes with an integrated rinsing function to allow the visualisation of the periodontal sulcus. Stambaugh, called the procedure perioscopy. Although it could have been used in implantology too, the limitations of the fiberoptical system do not permit an adequate detailed view which could be compared with image quality of a rigid endoscope. Due to a more open approach in implantology during exposure of implants the advantages of a 2.7 or 1.9 mm optical system are evident.

During the application of endoscopes since 1999 a shifting of procedures can be observed from exclusive use in maxillary augmentation (external osteoscopy as subantroscopy when applying the SALSA-technique) towards a broad application in routine implant placement.

The main application of endoscopy in implantology refers to the internal osteoscopic assessment of bone structure immediately before implant placement (Engelke). In the posterior mandibula, the shape and possible defect of an implant cavity can be observed intraoperatively. Especially lingual cortical plate perforation can be detected and differentiated from mandibular nerve lesion clearly. Thus critical complications are identified and an adequate management is facilitated this way. In the posterior maxilla, bone quality of regenerated bone after sinus floor augmentation is judged routinely meanwhile to select the appropriate loading concept after implantation. The sinus floor membrane is checked during internal sinus floor augmentation thus giving a substantial advantage to the surgeon compared with radiographic control only. Support immersion endoscopy enables the clinician to view intraoperatively the implant bone interface from an adequate working distance for every purpose.

A new aspect of internal osteoscopy has been added by combination of navigation systems and endoscopy as reported by Engelke & Repetto, (2003) using 3D- planning and flapless implantation during sinus floor augmentation procedures in the posterior maxillary zone. With the development of flapless sinus floor augmentation bone and soft tissue surgery planned on CT data three dimensionally, the location of incisions is guided by a template and transgingival implantation and augmentation are controlled endoscopically. Both components of the clinical procedure, endoscopic and template based navigation are mutual complementary.

The external osteoscopy meanwhile can be used not only when tunnelling the sinus floor mucosa for subantroscopic augmentation but also for supra- and paracrestal augmentation with rigid titanium barriers as reported recently (Engelke et al., 2004b). This technique requires intensive clinical training and therefore is not recommendable for general use in general practise so far. In contrast, internal osteoscopy has a very short learning curve and can easily can be performed after having received proper instruction on the use of the endoscopes.

In a similar manner, sulcus perioscopy (rigid perioscopy) can be carried out without previous special training when observing the cervical periimplant conditions during exposure and during prosthetic treatment. As a significant refinement of treatment safety the check of the cover screws as well as abutments and impression copings. This can be demonstrated using a direct viewing device compared with the radiographic control recommended earlier (Strid, 1985). There is an optical accuracy below 50μm for endoscopical observation compared with 500μm as previously obtained using panoramic radiographs.

As a consequence of the endoscopic technique, new treatment concepts of periimplantitis and treatment of bone loss may arise. Without open approach it has already been shown, that periimplant bone defects can be treated successfully by paracrestal tunnel formation, laser decontamination and subsequent augmentation in a secluded subperiosteal space around the implant without crestal opening (Sennhenn-Kirchner et al.).

CONCLUSION

Endoscopic procedures have been shown to be valuable and efficient tool to visualise various steps of implant treatment. The main procedures are: alveoloscopy, internal osteoscopy, external osteoscopy, and sulcus periodontoscopy.

Using these techniques, detection and management of complications in implantology already is supported and flapless implantation and augmentation may be facilitated in the near future.

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RESUMEN: El tratamiento mínimamente invasivo es un objetivo importante de los actuales procedimientos de implantes quirúrgicos. El objetivo del artículo es presentar los datos sobre los procedimientos endoscópicos en la cirugía de implantes para dar una visión general sobre la experiencia clínica en este campo. La endoscopia como parte de los procedimientos quirúrgicos en implantología, consiste en el uso de endoscopios rígidos de 1,9 a 2,7 mm de diámetro con una variedad de ejes de apoyo para obtener constante trabajo a distancia. Un sistema de irrigación limpia la ventana óptica. La endoscopia se ha aplicado de la siguiente manera: osteoscopia interior para inspeccionar las cavidades óseas, osteoscopia externa para visualizar las superficies óseas, alveoloscopia para el diagnóstico de defectos y periodontoscopia alveolar para visualizar las estructuras periimplantaria. Durante los primeros 5 años de aplicación entre 1999 y 2004, las siguientes intervenciones se llevaron a cabo: 263 alveoloscopias en 89 pacientes, 1568 internos osteoscopias en 595 pacientes, 429 periodontoscopias en 131 pacientes y 282 osteoscopias exteriores (subantroscopias y tunelización externa) en 236 pacientes. El método se relaciona con posibles complicaciones como infección, alveolitis seca, aspiración o la intolerancia del método, que no se ha observado. Con el uso de los diferentes tipos de endoscopia, los principales hallazgos patológicos fueron: defectos de hueso alveolar, granulomas, cuerpos extraños, insuficiencia de la estructura ósea, perforación, fenestración del hueso alveolar, periimplantitis, defectos óseos periimplantarios, inadaptación o daños de las supraestructuras del implante, incompleta regenerada de las estructuras después del aumento óseo. Los hallazgos endoscópicos han influido en el procedimiento quirúrgico en los siguientes casos: La eliminación de los tejidos blandos, la extracción de material extraño, la decisión sobre el aumento, la selección del diámetro de los implantes, el modo de inserción de implantes, la selección del tipo de implante, el modo de carga del implante. La endoscopia se ha convertido en una herramienta valiosa para ayudar a la cirugía de implantes, para garantizar la calidad de hueso, para comprobar la estructura ósea in vivo, ayudar al aumento mínimamente invasivo y verificar el ajuste de meso y suprastructuras en el tratamiento de implantes. Los primeros cinco años de uso intensivo de soporte y soporte de apoyo de inmersión de la endoscopia no mostró ninguna evidencia de morbilidad relacionada con el método y contribuye con datos valiosos para la colocación de implantes mínimamente invasivos.

PALABRAS CLAVE: endoscopía, implantes dentales, alveoloscopía, osteoscopía, periodontoscopía.

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