**Short versus Standard Length Implants with Sinus Floor Elevation for the Atrophic Posterior Maxilla**

**Kratki implantati nasuprot implantatima standardne dužine uz podizanje dna sinusa u slučaju atrofične stražnje maksile**

**Abstract**

**Objectives:** The aim of this clinical study was to compare clinical and radiological outcomes of short dental implants inserted in pristine bone to standard length implants inserted in combination with sinus floor elevation. **Materials and methods:** For this clinical study, the clinical and radiological outcome of 126 short dental implants (84 patients), inserted in pristine bone were compared with 312 standard length implants (156 patients), placed in combination with maxillary sinus floor elevation procedures. **Results:** The short implant group (test group [TG]; mean follow-up (± standard deviation) (SD) 56.6 ± 42.9 months) and the augmented group (control group [CG]; mean follow-up 41.6 ± 37.6 months) showed cumulative survival rates of 91.8% and 92.4%. Cumulative 5-year implant survival rates were 91.8% for the TG and 90.7% for the CG (p=0.421). Mean marginal bone loss was significantly higher in the CG than in the TG, with a mean MBL of 0.70 ± 0.72 mm in the TG and 0.96 ± 0.91 mm in the CG (p<0.001). A comparable and promising oral health-related quality of life (OHRQoL) was observed in the control and test groups. **Conclusions:** After over 3 years, short implants placed in the resorbed posterior maxilla obtained similar results to standard implants combined with maxillary sinus floor augmentation procedures.

**Introduction**

Dental implant therapy has proved to be a predictable and viable option for the prosthetic rehabilitation of the edentulous jaw, even in medically compromised patients (1-5). Furthermore, the rehabilitation achieved by dental implants seems to contribute to an increased oral health-related quality of life (6). The edentulous atrophic maxilla is a challenge which clinicians have to cope with when planning implants. The loss of teeth in this region leads to adaptive changes and morphological remodeling of the bone tissue with reduction of the alveolar ridge in vertical and horizontal dimensions (7). In the resulting atrophic posterior maxilla, it is not always feasible to use standard length implants. Clinicians must decide which technique to use to compensate for the bone loss. One option often used is the application of maxillary sinus floor elevation (SFE) in combination with implants of conventional length. This method is still regarded as gold standard.

**Uvod**

Terapija dentalnim implantatima pokazala se predvidljivom i održivom opcijom za proteetičku rehabilitaciju bezuba čeljusti, čak ako su pacijenti medicinski kompromitirani (1 – 5). Nadalje, čini se da rehabilitacija postignuta dentalnim implantatima pridonosi povećanju kvalitete života povezane s oralnim zdravljem (6). Bezuba atrofična maksila izazava je koji kliničari moraju riješiti pri planiranju implantoproteetičke terapije. Gubitak zuba u toj regiji rezultira adaptivnim promjenama i morfološki se remodelira koštano tkivo, uz smaženje alveolarnoga grebena u vertikalnoj i horizontalnoj dimenziji (7). U atrofičnoj stražnjoj maksili nije uvijek moguće upotrijebiti implantate standardne dužine. Kliničari moraju odlučiti kojom će tehnikom nadoknaditi gubitak kosti. Jedna od mogućnosti koja se često primjenjuje jest podizanje dna maksilarnoga sinusa u kombinaciji s implantatima konvencionalne dužine. Ta se metoda još uvijek smatra zlatnim stan-
standard (8). Applying this technique, it is possible to achieve survival rates over 90% in long-term evaluations (7). However, regardless of the well-documented long-term effectiveness of SFE, this invasive procedure involves several disadvantages such as increased cost and treatment duration, risk of infections, post-operative sinusitis, and limited amount of bone gain. Additionally, it is technically more complex and the outcome is dependent on the operator’s skills (7). Considering these factors, the patient might refrain from undergoing the surgical procedure of SFE (9).

Another option to overcome the problem of bone deficiency is using implants with a shorter length alternatively in order to avoid bone-augmenting operations altogether. Choosing short implants and to resign from augmentative surgery, will reduce the treatment time, the cost and morbidity for the patient, which could lead to higher patient compliance and satisfaction (6, 9-18).

A reduced vertical dimension of short implants has direct consequences regarding the static properties. In most cases, the clinical crown-to-implant ratio (C/IR) is increased in short implants, compared to implants with standard length. This results from a reduced intraosseous length of short implants, and an increased length of the crown, which is necessary to compensate for the reduced height of the atrophic alveolar ridge. While some studies show that an increased C/IR has no significant influence on survival rates (19-21), there are other reports which have reached the opposite conclusion (22). Regardless of its static properties, an increased crown length often does not produce a desirable esthetic outcome (7).

Existing studies suggest comparable survival and success rates for short and long dental implants (13, 14, 23, 24). In addition, the implant length does not seem to influence levels of osteoimmunological and microbiological markers in peri-implant tissues and survival rates (25). The results of some study further imply that there is even a smaller marginal bone loss (MBL) around short implants compared to long implants (7). There are not many studies providing evidence of longer follow-up time and larger sample sizes for short implants compared to long implants with surgical augmentative procedures. Consequently, there is only a limited number of meta-analyses showing superior survival rates for either. The results of the current study are promising regarding survival rates of short implants. Finally, a universally used and formalized definition for short implants has not yet existed in the literature. The definition for short implants is still ambiguously used in published studies and varies between \(<10.5\) and \(<6\)mm (10). However, implants with an intraosseous length of 8mm or less were classified as short implants at the first European Association for Osseointegration (EAO) consensus conference (26).

In conclusion, the aim of this clinical study was to investigate clinical and radiological outcomes of short dental implants inserted in pristine bone and to compare them to standard length implants inserted in combination with sinus floor elevation.
Materials and methods

Study design

This retrospective study investigated clinical and radiological outcomes of 126 short dental implants (≤8 mm, 84 patients), inserted in pristine bone and 312 standard length implants (>8 mm, 156 patients), inserted in combination with maxillary sinus floor elevation (Figure 1 and Figure 2). The study was conducted in accordance with the Helsinki declaration and the protocol was approved by the Ethics Committee of Rhineland-Palatinate, Germany (Registration number: 2019-14414, Landesärztekammer Rheinland-Pfalz). Patients presenting themselves with an edentulous posterior maxilla and reduced residual vertical bone height received detailed information about both treatment concepts and the associated advantages and disadvantages of both treatments. After each patient had decided for one of the treatment options, the implants were placed by experienced surgeons in the Department of Oral and Maxillofacial Surgery of the University Medical Centre Mainz, Germany, between January 2003 and December 2018.

Inclusion criteria

Patients receiving short dental implants (<8 mm) which were inserted in pristine bone or standard-length implants (>8 mm) that were placed in combination with maxillary sinus floor elevation procedures; Implants were placed in posterior maxilla

Exclusion criteria

Patients with horizontal augmentation procedures; Patients with short dental implants and vertical augmentation procedures; Palatal implants; Observation period < 1 month

Surgical procedure and outcome measures

The implant surgery was performed in accordance with the protocol of the manufacturer. Cumulative survival rates were calculated in a retrospective approach. In patients available for a clinical follow-up examination, the following clinical parameters were evaluated: mobility of the implant, radiographic marginal bone loss, probing depth, suppuration and sensitivity, and tenderness or pain upon function were determined (27). Furthermore, the percussion test, the Approximal Plaque Index modified by Lange et al. (28), as well as...

Materijal i metode

Studijski dizajn

U ovom retrospektivnom istraživanju uspoređivali su se klinički i radiološki rezultati 126 kratkih dentalnih implantata (≤ 8 mm, 84 pacijenata) ugrađenih u intaktnu kost s 312 implantata standardne dužine (> 8 mm, 156 pacijenata) ugrađenih u kombinaciji s podizanjem dna maksilarnoga sinusa (slike 1. i 2.). Istraživanje je provedeno u skladu s Helsinškom deklaracijom, a protokol je odobrio Etički odbor njemačke pokrajine Falačko Porajnje (Rhineland-Pfalz) (registracijski broj: 2019-14414, Landesärztekammer Rheinland-Pfalz). Pacijenti koji su imali bezuzu stražnju maksilu i smanjenu preostalu vertikalnu visinu kosti dobili su detaljne informacije o oba koncepta liječenja te s time povezanim prednostima i nedostatcima. Nakon što se svaki od njih odlučio za jednu od mogućnosti liječenja, implantate su, između siječnja 2003. i prosinca 2018. godine, ugradili iskusni kirurzi na Odjelu za oralnu i maksilofacijalnu kirurgiju Sveučilišnog centra u Mainzu.

Kriteriji za uključivanje

Pacijenti kojima su ugrađeni kratki dentalni implantati (< 8 mm) u intaktnu kost ili implantati standardne dužine (> 8 mm) u kombinaciji s postupcima podizanja dna maksilarnoga sinusa; implantati su postavljeni u stražnju maksilu.

Kriteriji za isključivanje

Pacijenti s postupcima horizontalne augmentacije; pacijenti s kratkim dentalnim implantacijama i postupcima vertikalne augmentacije; palatalni implantati; razdoblje praćenja < 1 mjesec

Kirurški postupci i mjerenje ishoda

Ugradnja implantata obavljena je u skladu s protokolom proizvođača. Kumulativne stope preživljenja izračunate su retrospektivnim pristupom. Pacijentima dostupnim za klinički kontrolni pregled ocjenjivani su sljedeći parametri: pokretljivost implantata, radiografski marginalni gubitak kosti, dubina sondiranja, gnojenje i osjetljivost te bol u funkciji (27). Uz to, evaluirani su nalazi perkusijskog testa, indeksa aproksimalnoga plaka modificiranoga prema Langeu i suradnicima (28) te indeksi plaka i krvena sulkusa modificira-
as Plaque Index and Sulcus Bleeding Index both modified by Mombelli et al. (29) were evaluated. Prosthodontic appliance design and technical complications could not be evaluated, as prosthetic restorations were mostly provided \textit{ad loco}. Radiological examination was conducted using orthopantomography at the time of examination. To determine the peri-implant marginal bone loss, the follow-up and postoperative radiograph were compared, by analyzing the mesial and distal crestal bone levels adjacent to the implant as described before (9). To examine Oral health-related quality of life the OHIP-G14 was used (30, 31). Additionally, a questionnaire with the following questions was issued (score 1 to 5): 1) How satisfied are you with your implant? 2) How satisfied are you with the operation? 3) How satisfied are you with the prosthetic restoration? Higher scores implied a higher satisfaction and high oral health-related quality of life, while lower scores indicate dissatisfaction and low oral health-related quality of life.

Data analysis

This trial is a descriptive and exploratory study. The study was created without a primary hypothesis. All data analysis was carried out according to a pre-established analysis plan. Descriptive p-values of tests are reported and no adjustments were made to multiple testing. Cumulative survival rates were estimated using the Kaplan-Meier function. To evaluate the statistical significance of differences in implant survival between both treatment groups, a log-rank test was performed. A cox model was fitted for age and gender to consider confounding variables due to clustering of multiple implants per patient. The associated hazard ratio and 95% confidence intervals were reported. For comparisons with respect to radiographic marginal bone loss, clinical parameters and OHRQoL, we applied the Mann-Whitney U Test. Statistical analyses were performed at 0.05 level of significance. They were performed using SPSS Statistics 23 V5 R (IBM, USA).

Results

Implant Survival Rates

In the examined time period, 126 short dental implants were inserted in the pristine bone of 84 patients of the test group, whilst 312 standard length implants were placed in combination with maxillary sinus floor elevation procedures in another 156 patients in the control group. The test group consisted of 30 male and 54 female patients, whereas in the control group 64 patients were male and 92 patients were female. The mean age of the test group was 65 years, and 59.9 years in the control group. The length of implants in the test group ranged from 4.5 to 8.0 mm, whilst the implant length ranged from 8.5 mm to 14 mm in the control group. The diameter of implants in the test group ranged from 3.0 mm to 5.5 mm, whereas the control group included implant diameters ranging from 3.3 mm to 6.0 mm. Implants were splinted if two implants were inserted next to each other. In the control group, an external sinus floor elevation was performed on 199 implants; 69 implants received an internal sinus floor elevation, 26 implants received both an internal and an external sinus floor elevation.
ternal sinus floor elevation, on 26 implants additional vertical augmentation procedures were carried out and on 10 implants it was not possible to distinguish between internal and external sinus floor elevation retrospectively.

Mean follow-up (± SD) was 56.6 ± 42.9 months (ranging from 1 to 160 months) in the TG and 41.6 ± 37.6 months (ranging from 0 to 126 months) in the CG. During the follow-up period, 14 implants in ten patients were lost in the TG. The reasons for implant loss in the short implant group were: n= 4 implants with early implant failure due to lack of osseointegration; n= 2 implants due to a condition after radiotherapy; n = 3 implants due to overloading, n= 2 implants due to periimplantitis; n = 1 implant was lost in the course of extraction of an adjacent tooth; n = 4 implants with unknown reasons. In the CG, 29 implants in 18 patients were lost. The reasons for implant loss were: n = 24 implants were removed due to periimplantitis; n = 2 implants with early implant failure due to lack of osseointegration; n = 3 implants with unknown reasons.

Cumulative 5- and 10-year implant survival rates for the TG were 91.8% and 82.5% respectively and 90.7% and 74.7% for the CG (p=0.421; Figure 3). The fitted Cox model (corrected for age and gender) favored the CG providing a hazard ratio (HR) of 1.16 (95%-confidence interval 0.55 to 2.26), however, the difference was not statistically significant (p=0.760; Figure 3).

Marginal bone loss

The marginal bone loss could be evaluated on the mesial and distal sides of 97 implants of the TG. There was no orthopantomogram available for 26 implants of the TG and another 3 implants of the TG were not assessable due to a poor quality of the orthopantomogram.

In the CG marginal bone loss could be assessed at the mesial sides of 222 implants and at the distal sides of 221 implants. There was no orthopantomogram available for 79 implants of the CG and, due to a poor quality of some orthopantomograms; another 11 implants of the CG were not assessable on the mesial side of the implant, whilst another 12 implants were not assessable on the distal side of the implant.

The mean time period between the initial, postoperative radiograph and that of the follow-up examination (±SD) was 42.1 ± 37.1 months in the TG (ranging from 1 to 139 months), whilst it was 32.9 ± 32.3 months in the CG (ranging from 1 to 121 months).

In this time period, the mean marginal bone loss (± SD) of the TG was 0.70 ± 0.72 mm, with an average of 0.75 ± 0.77 mm on the mesial side and 0.65 ± 0.67 mm on the distal side of the implant (figure 4). In the TG, the maximum marginal bone loss was 5.49 mm and the minimum was 0.00 mm. Compared with that, the mean marginal bone loss (± SD) of the CG was 0.96 ± 0.91 mm, with an average of 0.98 ± 0.86 mm on the mesial side and 0.94 ± 0.95 mm on the distal side of the implant. In the CG, the maximum marginal bone loss was 7.01 mm and the minimum was -0.16 mm. The intergroup difference showed statistical significance (p<0.001) indicating a significantly smaller average marginal bone loss in the TG (Figure 4).

Marginal gubitak kosti

Marginalni gubitak kosti mogao se procijeniti na mezijaloj i distalnoj strani 97 implantata u TG skupini. U toj skupini nije bilo dostupnog ortopantomograma za 26 implantata, a još tri implantata u istoj skupini nije bilo moguće procijeniti zbog loše kvalitete ortopantomograma.

U CG skupini marginalni gubitak kosti mogao se procijeniti na mezijalnom stranama 222 implantata i na distalnim stranama 221 implantata. U toj skupini nije bilo dostupnoga ortopantomograma za 79 implantata, a zbog loše kvalitete nekih ortopantomograma njih još 11 nije bilo moguće procijeniti na mezijalnoj strani implantata, a još 12 nije bilo moguće procijeniti na distalnoj strani.

Prosečno razdoblje između inicijalne, postoperativne radiološke analize i kontrolnoga pregleda (±SD) bilo je 42.1 ± 37.1 mjeseci u TG skupini (u rasponu od 1 do 139 mjeseci), a u CG skupini 32.9 ± 32.3 mjeseca (u rasponu od 1 do 121 mjeseca).

U tom razdoblju je srednji marginalni gubitak kosti (± SD) u TG skupini bio 0.70 ± 0.72 mm, s prosjekom od 0.75 ± 0.77 mm na mezijalnoj strani i 0.65 ± 0.67 mm na distalnoj strani implantata (slika 4.). U TG skupini maksimalni marginalni gubitak kosti iznosio je 5.49 mm, a minimalni 0.00 mm. U usporedbi s tim, srednji marginalni gubitak kosti (± SD) u CG skupini bio je 0.96 ± 0.91 mm, s prosjekom od 0.98 ± 0.86 mm na mezijalnoj strani implantata i 0.94 ± 0.95 mm na distalnoj strani. U CG skupini maksimalni marginalni gubitak kosti bio je 7.01 mm, a minimalni -0.16 mm. Za razliku među skupinama pokazala je statističku značajnost (p < 0.001) sa znatno manjim prosečnim marginalnim gubitkom kosti u TG skupini (slika 4.).
Clinical follow-up

14 patients (with 23 implants) of the TG and 5 patients (with 11 implants) of the CG attended the clinical follow-up examination. The average time between implant placement and clinical follow-up examination (± SD) was 6.5 ± 2.8 years in the TG and 8.1 ± 2.1 years in the CG. The mean overall clinical follow up was 7.01 ± 2.69 years.

None of the implants showed clinical mobility or sensitivity, tenderness or pain upon function. An evaluation of the Plaque Index modified by Mombelli et al. (29) showed no significant differences between the groups (p=0.123), with all implants of both groups reaching a satisfactory degree of oral hygiene (grade 0 and 1). Also the Approximal Plaque Index modified by Lange et al. (28), showed no statistically significant differences in the oral hygiene of both groups (p=0.214).

None of the implants of the TG showed bleeding on probing when applying the Sulcus Bleeding Index as modified by Mombelli et al. (29), thus having 100% of the TG implants reach a grade 0. Conversely, 3 implants (27.3%) of the CG, all in the same patient, showed isolated bleeding points (grade 1), whereas the remaining 8 implants (72.7%) of the CG did not show any bleeding on probing and were graded as grade 0. The intergroup differences regarding the Sulcus Bleeding Index did not reach statistical significance (p=0.214).

Kliničko praćenje

Kliničkom kontrolnom pregledu odazvalo se 14 pacijenata (s 23 implantata) u TG skupini i njih 5 (s 11 implantata) u CG skupini. Prosječno vrijeme između ugradnje implanta i kliničkoga kontrolnog pregleda (± SD) bilo je 6,5 ± 2,8 godina u TG skupini i 8,1 ± 2,1 godina u CG skupini. Prosječno ukupno razdoblje kliničkoga praćenja iznosilo je 7,01 ± 2,69 godina.

Ni jedan implantat nije bio pomičan ili osjetljiv, niti se pojavljivala bol u funkciji. Procjena indeksa plaka modifikiranog prema Mombelli i suradnicima (29) nije pokazala značajne razlike između skupina (p = 0,123), pri čemu je na svim implantatima u objema skupinama postignut zadovoljavajući stupanj oralne higijene (stupanj 0 i 1). Ni aproksimalni indeks plaka modifikiran prema Langeu i suradnicima (28) nije pokazao statistički značajne razlike u oralnoj higijeni u objema skupinama (p = 0,214).

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Pripostavljanju implantata u TG skupini ni jedan nije krvario pri sondiranju prema indeksu krvarenja sulksusa modifikiranome prema Mombelli i suradnicima (29), tako da je 100% implantata u toj skupini dobilo ocjenu 0. Suprotno tomu, kod 3 implantata (27,3%) u CG skupini, svi kod istoga pacijenta, pojavila su se izolirana mjesta krvarenja (1. stupanj), a kod preostalih 8 (72,7%) u toj skupini nije zabilježeno krvarenje pri sondiranju i ocijenjeni su ocjenom 0.
In the TG, the average probing depth was 2.0 ± 0.8 mm, whereas it was 2.7 ± 1.1 mm in the CG (p=0.000), indicating a statistically significant smaller probing depth in the TG.

Discussion

The present clinical study aimed to evaluate clinical and radiographic outcomes of short dental implants in comparison to standard length implants placed in combination with SFE procedures for the rehabilitation of posterior atrophic arches. Our study revealed similar results regarding implant survival. Interesting observations were made in terms of MBL and patient satisfaction, in which short implants compared favorably with standard length implants with SFE. Respecting the retrospective character of this study, the results should be interpreted with caution and causal links should not be concluded based on these results. Nevertheless, the present results are in line with findings of several randomized controlled trials, thus suggesting that short implants obtain similar, if not better clinical results, when compared with implants in standard length placed in combination with SFE.

In a randomized controlled trial (RCT) with split-mouth design, Felice et al. compared short implants (5 mm) with longer implants (≥ 10 mm) in augmented bone placed in posterior atrophic edentulous jaws (32). After a 5-year follow-up period, Felice et al. found no statistically significant differences with regards to the implant failures (32). A randomized controlled study compared 6-mm-long implants inserted in pristine bone with 11-mm-long implants placed in combination with SFE over a 5-year follow-up period (33). In this study, no statistically significant differences were found with regards to implant survival (33). Although the mean marginal bone loss (± SD) was smaller in the 6-mm group (0.12 ± 0.36 mm) compared with the 11-mm group (0.14 ± 0.63 mm), the differences did not reach a statistical significance (33). The average patient satisfaction (± SD) was slightly higher in the short implant group (9.4 ± 0.8 out of a maximum score of 10) in comparison to the 11-mm group (9.2 ± 0.8), however, these intergroup differences were also not statistically significant (33). Furthermore, no statistically significant differences regarding the plaque accumulation

Oral health-related quality of life

A total of 17 patients with 31 implants, of which 11 patients of the TG and further 6 patients of the CG, agreed to complete the questionnaires regarding the OHRIQoL. Mean OHRQI-G14 scores were 1.9 ± 3.4 (ranging from 0 to 9) in the TG and 5.0 ± 4.5 (ranging from 0 to 10) in the CG (p=0.180; Figure 5). On average (± SD), the patients of the TG rated their satisfaction with the implant 4.9 ± 0.3 out of a maximum of 5, whereas the mean (± SD) score in the CG was 3.8 ± 1.5 (p=0.033), indicating a significantly higher satisfaction in the group of short implants. Regarding the satisfaction with the operation (TG: 4.8 ± 0.4; CG: 4.7 ± 0.5; p=0.718) and the prosthetic restoration (TG: 4.6 ± 0.7; CG: 3.5 ± 1.5; p=0.091), comparable results were observed.

Rasprava

Cilj ovoga kliničkog istraživanja bio je procijeniti kliničke i radiološke rezultate kratkih dentalnih implantata u usporedbi s implantatima standardne dulžine postavljenima u kombinaciji s postupcima podizanja dna sinusa. Usaglašeno su zapažanja o zadovoljstvu pacijenata – kratkim implantatima postignuti su povoljni rezultati u usporedbi s onima standardne dulžine s podizanjem dna sinusa. Međukupne razlike, kada je riječ o indeksu kvrarenja sulku-sa, nisu postigle statistički značajnost (p = 0,214).

U TG skupini prosječna dubina sondiranja bila je 2,0 ± 0,8 mm, a u CG skupini iznosila je 2,7 ± 1,1 mm (p = 0,000), što upućuje na statistički značajno manju dubinu sondiranja u TG skupini.

Kvaliteta života povezana s oralnim zdravljem

Ukupno 17 pacijenata s 31 implantatom, od čega 11 iz TG skupine i 6 iz CG skupine, pristalo je ispuniti upitnike OHRIQoL-a. Prosječni rezultati dobiveni za OHRQI-G14 bili su 1,9 ± 3,4 (u rasponu od 0 do 9) u TG skupini i 5,0 ± 4,5 (u rasponu od 0 do 10) u CG skupini (p = 0,180; slika 5). Prosječno (± SD) su pacijenti u TG skupini svoje zadovoljstvo implantatom ocijenili s 4,9 ± 0,3 od maksimalnih 5, a srednja (± SD) ocjena u CG skupini bila je 3,8 ± 1,5 (p = 0,033), što pokazuje znatno veće zadovoljstvo u skupini s kratkim implantatima. Kada je riječ o zadovoljstvu operacijom (TG: 4,8 ± 0,4; CG: 4,7 ± 0,5; p = 0,718) i protetičkim nadomjesk-vom (TG: 4,6 ± 0,7; CG: 3,5 ± 1,5; p = 0,091), uočeni su usporedivi rezultati.
and bleeding tendency were found (33). In a RCT over 3 years, Bechara et al. compared short implants (6 mm) in 33 patients with standard length-implants (≥ 10 mm) placed in combination with external SFE in 20 patients (9). Survival rates on implant-level were 100% in the short implant group and 95.6% in the augmented group (9). As in our study, the radiological results revealed a significantly smaller mean marginal bone loss in the short implant group (9). Regarding patient satisfaction, no statistically significant differences could be found concerning function, esthetics, cleanliness and the overall satisfaction (9). However, patient satisfaction was significantly higher in the short implant group regarding the treatment costs (9). Interesting observations regarding the quality of life in both implant groups were also made in a RCT by Taschieri et al., who compared short dental implants (6,5 to 8,5 mm) with longer ones (10 mm or longer) placed with external SFE (34). Over a follow-up period of 3 years, the authors found an implant survival of 100% in both groups and no statistically significant differences in implant failure and mean marginal bone loss (34). The clinical parameters regarding plaque accumulation, bleeding on probing and implant mobility were similar in both groups (34). However, in the first 6 days after surgery, patients with short dental implants had significantly lower pain levels, with a reduced intake of analgesics, as well as less swelling, hematoma and impairment of daily activities such as sleeping, chewing and speaking (34). Nevertheless, patient satisfaction was similar after 1 year, with no significant differences in all aspects, besides the easiness of oral hygiene maintenance, which was considered significantly better by patients of the short implant group (34). When comparing 5- to 6-mm-long implants with ≥ 10 mm-long implants placed in combination with an internal SFE over 3 years, a study by Gastaldi et al. also found out that all patients were fully or partially satisfied with the function and esthetics, with a slightly higher patient satisfaction in the short implant group. (35). Generally, both short implants in native bone and those in standard length placed in combination with SFE appeared to reach high levels of patient satisfaction (9, 34, 35). However, considering the minimal invasiveness, the associated morbidity and treatment costs, patients seem to prefer short implants (9, 34, 35).

A randomized controlled study by Thoma et al. compared 6-mm-long implants with 11-mm-long implants placed in combination with lateral SFE (36). Over a 5-year follow-up period, Thoma et al. did not find statistically significant in- tergroup differences with regards to implant survival, marginal bone loss and oral health impact profile (OHIP-49) (36). Survival rates on implant level were 98.5% in the short implant group versus 100% in the augmented group (36). On implant level, mean marginal bone loss was 0.45 ± 0.79 mm in the short implant group and 0.45 mm ± 0.91 mm in the augmented group (36). No statistically significant differences were found regarding probing depth, bleeding on probing and plaque accumulation (36). Furthermore, the crown-to-implant ratio did not seem to have a statistically significant effect (36). After 5 years, median overall OHIP-49 scores were 3.0 in the short implant group and 5.0 in the augmented group, showing significantly improved scores from base-

(33). Nisu pronađene ni statistički značajne razlike u nakupljanju plaka i sklonosti krvarenju (33). U randomiziranoj kontroliranoj istraživanju tijekom tri godine, Bechara i suradnici uspoređili su kratke implantate (6 mm) kod 33 pacijenta s implantatima standardne dužine (≥ 10 mm) postavljenima u kombinaciji s vanjskim podizanjem dna sinusa kod 20 pacijenata (9). Stope preživljenja na razini implantata bile su 100 % u skupini s kratkim implantatima i 95.6 % u skupini s augmentacijom (9). Kao i u našem istraživanju, radiološki na-

laži pokazali su znatno manji srednji marginalni gubitak ko-

sti u skupini s kratkim implantatima (9). Kada je riječ o zado-

voljstvu pacijenata, nisu zabilježene statistički značajne razlike u vezi s funkcijom, estetikom, čistoćom i ukupnim zadovolj-

stvom (9). Međutim, zadovoljstvo pacijenata bilo je znatno veće u skupini s kratkim implantatima s obzirom na troškove liječenja (9). Zanimljiva zapažanja o kvaliteti života u objema skupinama pokazalo je i randomizirano kontrolirano istraži-

vanje Taschierija i suradnika. Oni su uspoređivali kratke den-

talne implantate (6,5 do 8,5 mm) s dužima (10 mm ili duže) postavljenima s vanjskim podizanjem dna sinusa (34). Tije-

kom trogodišnjega praćenja autorii su ustanovili 100-postotno preživljenje implantata u objema skupinama i bez statistički značajnih razlika u neuspjehu implantata i srednjem marginalnom gubitku kosti (34). Klinički parametri o nakupljanju plaka, krvarenju pri sondiranju i pokretljivosti implantata, bili su slični u objema skupinama (34). No prvih šest dana poslije operacije pacijenti s kratkim dentalnim implantatima ima-

li su značajno nižu razinu boli te zato i manji unos analgetika, te manje otkline, hematome i tegobe pri svakodnevnim ak-

tivnostima poput spavanja, žvakanja i govora (34). Ipak, za-

dovoljstvo pacijenata bilo je slično nakon jedne godine, bez značajnih razlika u svim aspektima, osim u lakoći održava-

ju oralne higijene koju su pacijenti iz skupine s kratkim im-

plantatima ocijenili znatno boljom (34). Kada se tijekom tri godine uspoređuju implantati dužine od 5 do 6 mm s oni-

ma dužine ≥ 10 mm postavljenim u kombinaciji s unutar-

njim podizanjem dna sinusa, Gastaldi i suradnici u svojem su-

istraživanju također istaknuli da su svi pacijenti potpuno ili dijelomično zadovoljni funkcijom i estetikom, uz nešto veće zadovoljstvo onih u skupini s skupinama s kratkim implantatima (35). Op-

čenito, čini se da se i kratkim implantatima u nativnoj kosti i implantatima standardne dužine postavljenim u kombinaciji s podizanjem dna sinusa, postiže visoka razina zadovoljstva pa-

cijenata (9, 34, 35). No s obzirom na minimalnu invazivnost, pridruženi morbiditet i troškove liječenja, čini se da pacijenti preferiraju kratke implantate (9, 34, 35).

U randomiziranom kontroliranom istraživanju Thoma i suradnici uspoređivali su implantate dužine 6 mm s onima od 11 mm postavljenim u kombinaciji s lateralnim podizanjem dna sinusa (34). Tijekom petogodišnjega praćenja, autorii ni-

su pronašli statistički značajne razlike među skupinama u pre-

življenju implantata, marginalnom gubitku kosti i utjecaju na oralno zdravlje (OHIP-49) (36). Stope preživljenja na razini implantata bile su 98,5 % u skupini s kratkim implantatima prema 100 % u skupini s augmentacijom (36). Na razini im-

plantata, prosječni marginalni gubitak kosti bio je 0,45 ± 0,79 mm u skupini s kratkim implantatima i 0,45 mm ± 0,91 mm u skupini s augmentacijom (36). Nisu pronađene statistički
line in both groups (36). The OHIP-survey was designed by Slade and Spencer to assess the impact of oral health on the subjective well-being (37, 38). Amongst other fields, it has become well established in the rating of different treatment options in implant therapy (39-45). The shortened version, the OHIP-14, explains 94% of the variance of the OHIP-49 and therefore is a reliable and efficient tool in the assessment of the oral health impact under clinical conditions (37, 46).

In our study, the German shortened version of the OHIP-survey (OHIP-G14) was applied and yielded very similar values to those in the study by Thoma et al.. In the test group, average overall scores were 1.9 ± 3.4 (ranging from 0 to 9), whilst the control group had a mean overall score of 5.0 ± 4.5 (ranging from 0 to 10) (p=0.180).

Our study is similar to a retrospective cohort study by Pieri et al., in which short implants (6 to 8 mm) were compared to standard length implants (≥ 11 mm) placed in combination with a lateral sinus elevation procedure (47). The mean observation period was 47.03 ± 7.46 months for the control group and 44.18 ± 6.42 months for the test group (47). After a follow-up of at least 3 years, implant survival was 90.6% in the augmented group and 95.8% in short implant group, with differences in proportion not being statistically significant (47). These results are similar to the 3-year Kaplan-Meier-estimator of our study, estimating a cumulative survival of 93.1% for the control group and 91.8% for the test group.

Conclusion

In conclusion, the results of this study are in general agreement with those found in the literature, providing promising clinical data for short dental implants in the edentulous atrophic maxilla. However, larger trials carried out over a long-term follow-up period are needed to evaluate whether short- and medium-term clinical advantages of short implants can be maintained in the long-term. This study was carried out under real clinical conditions with only very few exclusion criteria, which should allow experienced operators to treat patients with similar characteristics in other medical centers to obtain similar results. Within the limitations due to the retrospective nature of the study and due to a high number of drop-outs, short implants showed similar clinical and radiological results to implants in standard length in combination with sinus floor elevation procedures. When considering the associated patient morbidity, cost and treatment duration, short implants are a promising treatment option.

Conflict of Interest

Dr. Schiegnitz reports Grants and Personal fees from Dentsply, personal fees from Geistlich, personal fees from Sanofi-Aventis, personal fees from Septodont, grants and personal fees from Straumann.

Sukob interesa

Dr. Schiegnitz prijavio je projekte i osobne naknade od Dentsplyja, te osobne naknade od Geistlicha, Sanofi-Aventisa te Septodonta, potpore i osobne naknade od Straumann...
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Author's contribution: ES, NH, KS, JK, KS and BA participated in data collection and interpretation; ES, NH, KS, JK and KS drafted the manuscript. All authors have read and approved the final manuscript.

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