

COMPARISON OF TWO DIFFERENT IMPLANT SITE PREPARATION TECHNIQUES: PIEZOSURGERY VS STANDARD DRILLING

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Keywords: dental implantation, piezosurgery, standard drilling, implant stability.

Summary

Relevance of the problem. Over the years, dental implant placement has proven to be a routine and reliable procedure. Osteotomy site preparation has a significant impact on implantation success rate. Surgery using piezosurgery is used as an alternative method for osteotomy. Piezosurgery concept has proven to reduce mechanical and thermal tissue trauma. Aim. Compare clinical differences between piezosurgery (PS) and standard drilling (SD) in dental implantation. Materials and methods: A systematic review was based on the PRISMA guidelines. Search was carried out in electronic databases. Researched studies were observational, published less than 10 years ago, in English. Studies that involved immediate implantation or bone augmentation were excluded, as well as patients with metabolic bone diseases or using bisphosphonate therapy. Results. Regarding crestal bone loss, 3 out of 4 articles stated that there were no statistically significant differences between standard drilling and piezosurgery group. One study, however, disclosed that piezosurgery showed better preservation of crestal bone after 3 years. 5 studies measured primary stability and did not find any significant differences. Secondary stability, however, was significantly higher in the piezosurgery group at 2nd and 3rd months. 5 studies that measured the duration of surgeries reported longer osteotomy time for the piezosurgery group. Pain level on VAS scale, oppositely, was lower in piezosurgery group. Conclusion. In conclusion, piezosurgery can be considered as an alternative to standard drilling. In terms of success rate, crestal bone loss and primary stability, results seem to be very similar in both groups. Piezosurgery,

although, seems to be advantageous achieving secondary stability and maintaining lower pain levels during the healing process.

Introduction

Over the years, dental implant placement has proven to be a routine and reliable procedure. One of the factors influencing the success of dental implant placement is the method of preparing important sites for surgical osteotomy [1]. However, doctors are seeking to reduce the time of functional stress that occurs after the implantation, as patients wait in uncomfortable situations that affect their quality of life. Primary stability of the implant is the main factor influencing osseointegration, as microvibrations can cause the collision of fibrous tissues around the implant, which can lead to its destruction [2, 3]. Implant stability is considered a combination of primary and secondary stability. The stability of the primary implant decreases over time and depends on the properties of the implant, the quality of the bone and the insertion technique, while the secondary implant stability increases over time without integrating the new bone into the surface of the implant [4]. Piezoelectric devices have been shown to stimulate the osteoblastic activity of the surrounding implants, as concluded in animal models [5, 6, 7]. Histological examination shows that implants placed during piezosurgery (PS) can show the same osseointegration as placed by standard drilling (SD) [8]. Osteotomy with ultrasound results as less traumatic: favorable wound healing and reduced microfractures, as well as the presence of a smear layer. This appears to be a more effective first step in bone healing, increasing the amount of bone morphogenetic protein (BMP) [9]. On the other hand, piezo surgery appears to be more dependent on continuous cooling if high temperature develops during the osteotomy.

The aim: compare clinical differences between piezosurgery (PS) and standard drilling (SD) in dental implantation.

Materials and methods

A systematic review was performed according to PRISMA guidelines. A focused question was created in accordance with the PICOS model: does the method of preparation - piezosurgery or standard drilling - in an osteotomy site affect the clinical parameters of implants? On 1 February 2021, a systematic search was conducted to identify all peer-reviewed articles investigating the clinical parameters of implants inserted using piezosurgery preparation or conventional drilling method in the following databases: PubMed, ResearchGate and The Cochrane Library. Following keywords were used: *dental implantation, piezosurgery, standard drilling, implant stability*. The inclusion and exclusion criteria are displayed in Table 1. A comparison of the included studies using statistical analysis was limited because of the heterogeneity of the studies.

Table 1. Inclusion and exclusion criteria

Inclusion	Exclusion
Randomised clinical trials	Case report, case series, systematic reviews, retrospective studies, cohort studies, posters, letters to editor.
English language	Not English language
Studies with adult people (over 18 years of age)	Studies with animals, in vitro studies
Publications up to 10 years	Publications older than 10 years
Delayed implantation	Immediate implantation
No grafting before implantation	Grafting before implantation
Healthy, non-smoking patients	Patients with metabolic bone diseases or using bisphosphonates

Table 2. General characteristics of the studies

Author, year	Study sample	Gender	Implant site	Parameters of implant	Follow up time	Implant stability	Crestal bone loss	Surgery duration	Pain level on VAS scale
C. Stacchi et al. 2011	20 patients (40 implants)	12M/ 8F	Maxillary premolar	4.0 x 10 mm	7, 14, 21, 28, 42, 56, and 90 days.	+	-	-	-
L. Canullo et al. 2013	15 patients (30 implants)	NM	Mandibular molar	3.8 x 10 mm	8 and 12 weeks	+	+	-	-
Da Silva Neto et al. 2014	30 patients (60 implants)	6M/24F	Maxillary premolar	3.5 x 13 mm	Baseline, 90, 150 days	+	-	-	-
M. Mozzati et al. 2019	49 patients (98 implants)	NM	Maxillary and mandubular jaw	NM	3 days, 1 week, 2 weeks, 1 month, 3 months, 6 months, 1 year and 3 years.	-	+	-	-
M. Maglion et al. 2019	75 patients (150 implants)	31M/44F	Maxillary and mandubular jaw	3.8 and 4.5 x 10 mm	Between 8 hours to 7 days, 15 d	-	-	+	+
C. Makary et al. 2017	10 patients (21 implants)	NM	Maxillary and mandubular jaw	4.0 x 10 mm	Baseline, 4 week	+	-	-	-
A. N. Alattar et al. 2018	28 patients (54 implants)	12M/16F	Maxillary and mandubular jaw	3.4 - 4.3 x 8 - 12 mm	8 week, 16 week	+	-	-	-
A. Scarano et al. 2018	50 patients (50 implants)	21M/29F	Posterior mandible	NM	1, 2, 4, 6 days, 3 months	-	+	+	+
G. Peker Takdal et al. 2015	14 patients (38 implants)	4M/10F	Maxillary posterior	4.1 x 8, 10, or 12 mm	2, 4, 8, 12, and 24 weeks.	-	+	+	+

Results

An initial search in electronic databases yielded 186 articles. Eventually, 9 articles that met the inclusion criteria were included in the qualitative synthesis. All of the publications were randomly controlled trials. Characteristics of all studies are displayed in Table 2. Regarding a crestal bone loss, 3 of the 4 included publications reported that there were no statistically significant differences ($p > 0.005$) between groups [11, 17, 18]. M. Mozzati et al., however, claimed that PS group showed statistically significantly ($p < 0.01$) better preservation of crestal bone after 3 years: bone loss was 0.42 ± 0.14 mm and 0.33 ± 0.13 mm in SD and PS groups respectively [13]. 5 of the studies included in this systematic review measured dental implant stability [10 - 12, 15, 16]. No significant differences ($p > 0.05$) were reported in primary stability in those studies. According to C. Makary et al., the primary implant stability did not differ neither at the baseline, nor after 4 weeks between groups, whatever the bone quality was [15]. In the split-mouth study by Neto et al., the results reported that there was far less variation in the implant stability values obtained at all follow-up times in the piezosurgery group compared to standard drilling groups [12]. Regarding secondary stability, values in the piezosurgery group at 2nd and 3rd months were higher compared to standard drilling group ($p < 0.05$) [10 - 13, 15, 16]. All of the four studies that measured the duration of surgeries reported that osteotomy time for PS group was significantly longer than for SD group ($p < 0.05$) [14, 16 - 18], but pain level on VAS scale was lower in PS group [14, 17, 18].

Discussion

The main objective of this study was to compare different dental implant site preparation techniques: piezosurgery and standard drilling. However, since the number of the homogenous trials were extremely limited, only qualitative study analysis could have been performed. Results showed that primary stability in both techniques did not significantly differ [10 - 12, 15, 16]. However, secondary stability and values were higher in the piezosurgery group at 2nd and 3rd months [10 - 12]. Studies investigating crestal bone loss did not find any compelling changes between groups, except 1 [13] stated better preservation results in piezosurgery group. 5 articles that measured osteotomy time reported significantly longer time consumption in piezosurgery group than SD group [10, 14, 16 - 18]. In contrast, PS group revealed lower pain levels on the VAS scale up until 1 week after the dental implantation [14, 17, 18]. Several ex vivo studies were performed to evaluate initial stability using an RFA device and to compare piezosurgery to standard drilling for implant site preparation. S. Gandhi et al. [7] found a statistically higher stability of

the primary implant using PBS compared to CD bovine ribs, however, the quality of the ribs was not measured, which may have influenced the results. In contrast, Baker et al. in a study with beef ribs and K. Sagheb et al. [6] in a study of pig bone blocks showed that baseline stability results were similar for both groups. As in ex vivo studies, however, nobody was able to assess the stability of the implant after a healing phase. The mechanical and thermal trauma that occurs in the tissues associated with the preparation of the surgical site greatly influence the course of bone healing and osseointegration processes. Histological evidence of live osteocyte cells characterized by physiological dimensions and morphology on excised edge surfaces probably indicates reduced piezoelectric osteotomy incision trauma without deleterious side effects [20]. In addition, the differences in porous bone were not obvious. This phenomenon reduces the signs of inflammatory processes and causes faster bone remodelling with increased levels of BMP-4 and TGF- β molecules [21].

Conclusions

In conclusion, piezosurgery can be considered as an alternative to standard drilling. In terms of success rate, crestal bone loss and primary stability, results seem to be very similar in both groups. Piezosurgery, although, seems to be advantageous achieving secondary stability and maintaining lower pain levels during the healing process. However, current studies are not sufficient enough to confirm these findings.

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**DVIEJŲ SKIRTINGŲ IMPLANTO LOŽĖS
PARUOŠIMO BŪDŲ PALYGINIMAS:
PJEZOCHIRURGIJA IR
STANDARTINĖ OSTEOTOMIJA
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Raktažodžiai: dantų implantavimas, pjezochirurgija, standartinė osteotomija, implantu stabilumas.

Santrauka

Problemos aktualumas. Dantų implantavimas tapo įprastinė ir labai sėkminga procedūra, kurios vienas iš sėkmę lemiančių veiksnių yra osteotomijos technika implantu ložės paruošimui. Šiuo metu pjezochirurgija implantacijos srityje taikoma kaip alternatyvus metodas, mažinantis mechanines ir šiluminės audinių traumas.

Tikslas - palyginti klinikinius pjezochirurgijos ir standartinės osteotomijos skirtumus, implantuojant dantis.

Medžiaga ir metodai. Sisteminė apžvalga buvo paremta PRI-

SMA gairėmis. Elektroninė paieška buvo vykdoma PubMed, ResearchGate ir Cochrane Library duomenų bazėse. Įtraukimo kriterijai: klinikiniai tyrimai, publikuoti ne daugiau kaip prieš 10 metų, anglų kalba. Tyrimai, kurių dalyviams reikėjo vienmomentės implantacijos, kaulo augmentacijos, sergantieji metabolinėmis kaulų ligomis arba vartojantys bisfosfonatus, įtraukti nebuvo.

Rezultatai. Kalbant apie alveolinio kaulo netekimą, 3 iš 4 straipsnių buvo teigiama, kad statistiškai reikšmingų skirtumų tarp standartinės osteotomijos ir pjezochirurgijos grupės tiriamųjų nenustatyta. M. Mozzati ir kt. teigė, kad pjezochirurgija po 3 metų geriau išsaugo alveolės kaulą. 5 tyrimai matavo pirminį stabilumą ir reikšmingo skirtumo nenustatė. Antrąjį ir trečiąjį mėnesį pjezochirurgijos grupėje antrinis stabilumas buvo reikšmingai didesnis. 5 tyrimuose pastebėta, kad osteotomijos laikas pjezochirurgi-

jos grupėje buvo ilgesnis, nei standartinėje. Skausmo lygis pagal VAS skalę pjezochirurgijos grupėje buvo mažesnis iki vienos savaitės po procedūros.

Išvada. Pjezochirurgija gali būti įprastinio gręžimo alternatyva. Kalbant apie sėkmės rodiklį, alveolinio kaulo netekimą ir pirminį implanto stabilumą, rezultatai atrodo labai panašūs abiejose grupėse. Pjezochirurgija naudinga, norint pasiekti geresnį antrinį stabilumą ir palaikyti žemesnį skausmo lygį gijimo metu.

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