ORIGINAL ARTICLE

CONTENTS

Experience in clinical application of various protocols in bone insertion channel preparation for dental implants

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ABSTRACT

Aim: To analyze and compare the results of clinical usage of two protocols of bone drilling during the surgical stage of dental implantation.

Materials and Methods: The clinical study group was formed from 30 patients. All selected patients underwent dental implantation in the lateral segments of the jaws using a delayed two-stage technique, using the standard drilling protocol (1000 rpm) and slow (50 rpm). The study included measuring implants' torque during the installation, bone density, and marginal bone resorption after 1,5 years.

Results: The slow bone tissue preparation protocol showed the higher torque level during the installation, and did not cause significant changes in the structure of the bone tissue and level of sauserisation compared to the standard protocol for preparation.

Conclusions: The usage of two different protocols showed a significant difference at the moment of installation. However, it did not reveal any statistically significant differences between the two sgroups of patients during the long-term follow-up.

KEY WORDS: dentistry, implantation, bone, osseodensification, osseointegration

Wiad Lek. 2025;78(4):777-782. doi: 10.36740/WLek/203883 DOI

INTRODUCTION

Restoration of dentition in patients with partial and complete edentulousness using dental implant-supported structures is now recognized as an effective and predictable treatment method, a serious alternative to partial and complete removable prosthetics. The basic designs of dental implants and materials for their manufacture were invented from the 60s to the 90s of the XX century and have undergone mostly minor modifications to date. But since the 90s of XX century, clinical implantation protocols have developed significantly. Knowledge has been significantly enriched regarding the process of osseointegration, long-term use of dental implants, problems of repair of orthopedic structures and "rescue-rehabilitation" of osseointegrated structures in various fractures, protocols and approaches to bone bed preparation, etc. [1-4]. In the trend of the listed research areas, the osseodensification protocol proposed by S. Huwais also looks original and promising in clinical application. The use of the osseodensification protocol showed promising results in terms of improving osseointegration, increasing bone density in the preparation area, reducing the risk of Schneiderian membrane injury and increasing the transverse size of the alveolar crest, reducing the level of bone resorption during sauserisation. A standard high-speed protocol for implant bed preparation (osteotomy, with the use of aggressive cutting surgical burs at high speeds clockwise with constant irrigation of the surgical field) leads to bone loss. The developed osseodensification protocol involved using a unique non-aggressive design of burs that prepared counterclockwise bone tissue [5-7].

The main ideas of the "adepts" of osseodensification were that such a phenomenon provides a denser and closer contact of the bone and the implant surface, which increases the torque during the insertion of the implant itself and reduces the time to achieve osseointegration of the dental implant. The osseodensification protocol increases the primary stabilization of the implant and allows for the installation of larger diameter implants compared to the standard protocol since the process of bone compaction increases the volume of the alveolar crest. The osseodensification protocol proposed by S. Huwais was performed with modified surgical burs with the function of bone densification (reduced number of cutting edges and their design), and such burs could be used at a speed of 800-1200 rpm counterclockwise - mode without osteotomy, and clockwise – cutting mode [5,8,9].

In modern conditions, the trend towards the use of osseodensification techniques has affected a significant number of dental implantation systems, which has manifested itself in the improvement of the design of milling cutters, which are becoming more universal – at high speeds, they operate in osteotomy mode, and at low speeds – 50-70 rpm – they perform osseodensification. These modifications began to spread from 2018-2019 and, accordingly, long-term results of the use of such new surgical dental implantation protocols have not yet been accumulated. Accordingly, this area of dental implantology requires further research at various levels – from experimental to clinical [10,11].

AIM

The objectives of study were to analyze and compare the results of clinical usage of two protocols of bone drilling during the surgical stage of dental implantation – standard and slow protocols.

MATERIALS AND METHODS

The clinical study group included 30 patients (15 men and 15 women) from a private dental healthcare institution. Two clinical groups were randomly selected alternately, using the standard speed of bone tissue preparation and the slow speed. The average age of the patients was 36.10±5.68 years (M=36.50). All patients underwent intraosseous dental implantation in the lateral segments of the jaws using a delayed two-stage technique with "DENTIUM" "SuperLine NEW" system (Korea). The following bone tissue preparation protocols were used: standard high-speed - 1000 rpm at a torque of 35 N×cm with water cooling; slow – formation of the primary hole with guide mills at a speed of 1000 rpm at a torque of 35 N×cm with water cooling and subsequent use of final mills at a speed of 50 rpm at a torque of 35 N×cm without water cooling. After installation, the torque during fixation was measured using a torque wrench (three times, the average value was entered into the intermediate tables). All patients were prescribed a prophylactic course of amoxicillin/clavulanate, for the prevention of pain syndrome – ibuprofen. 6–7 months after the surgical stage, the dental implant was opened to install a gingival former. The strength of the product's fixation in the bone tissue was measured using an XNTW torque wrench – the maximum torque of the product was 70 N×cm. After a year and a half, the patients were called to the clinic, the oral cavity was examined, and the clinical status of the tissues around the structure fixed on the implant was determined. The patients were referred for a repeated CBCT (or panoramic study) of the jaws. Using archival data, the relative radiographic density of the bone tissue around the installed dental implant (at 12 arbitrary positions on the image) was compared in a computer program with the indicators of the same segment before dental implantation. The depth of bone resorption around the implant neck was measured, considering that all products were installed at the level of the alveolar bone edge. The analysis of the obtained data was carried out using Microsoft Excel 2016 and the software package "BioStat LE" (version 7.6.5), where descriptive statistics and comparative statistics methods were applied with the calculation of ANOVA and Student's criteria.

RESULTS

The analysis of the results of measuring the torque of dental implants achieved during installation showed that its level differed between groups (Table 1). Overall, the torque level during dental implant placement was 38.90±7.92 N×cm (M=39.50), with a minimum value of 29.00 N×cm and a maximum of 50.00 N×cm. In the first group of patients (where the standard high-speed implant bed preparation protocol was used), the average implant torque during placement was 31.33±1.95 N×cm (M=31.00), with a minimum value of 29.00 N×cm and a maximum value of 35.00 N×cm. In the second group, the average implant torque during placement was 46.47±1.89 N×cm (M=46.00), with a minimum value of 44.00 N×cm and a maximum value of 50.00 N×cm. Using comparative statistics methods showed a statistically significant difference between the torque values in the two groups. The value of the ANOVA criterion was 5.42×10^{-19} and the Student t-test was 3.97×10^{-11}.

At the time of opening the implants, the third of the installed products was partially covered by an overgrown cortical plate of newly formed bone tissue, which had to be carefully removed mechanically with a ball-shaped surgical bur with water cooling at minimum speed. After removing the plug screw, the internal canal of the implant was washed with a 0.05% chlorhexidine bigluconate solution, after which a manual implant driver was inserted into the implant canal, to which the torque wrench ring was fixed. The torque of the installed implant was recorded by attempting to turn the "leg" of the torque wrench - up to a maximum of 50.00 N×cm.

Table 1. Implants' torque level at moment of insertion, N×cm

Index	Group 1	Group 2	General
Torque	31.33±1.95 (M=31.00)	46.47±1,89 (M=46.00)	38.90±7,92 (M=39.50)
Min.	29.00	44.00	29.00
Max.	35.00	50.00	50.00

Note: $p<0.05$

Table 2. The level of marginal bone resorption around the implants' cervices after the one year of prosthetic stage, mm

	Group 1	Group 2	General
M±m (Median)	0.46±0.10 (M=0.45)	0.47±0.09 (M=0.45)	0.47±0.10 (M=0.45)
Min.	0.35	0.35	0.35
Max.	0.60	0.60	0.60

Note: $p=0.35$

Table 3. The average x-ray jaw bone density among patients, dHu

	Group 1		Group 2	
	Before implantation	1.5 years after implantation	Before implantation	1.5 years after implantation
M±m (Median)	719.93±43.10 (M=720.00)	722.53±27.49 (M=721.00)	710.00±28.52 (M=704.00)	713.80±20.46 (713.00)
Min.	645.00	690.00	678.00	692.00
Max.	789.00	780.00	765.00	754.00

It was determined that all the implants installed withstood such a load without rotation, regardless of the clinical group of the study. No great effort was made to avoid damaging the thread of the implant's internal canal. One year after the fixation of the orthopedic structure, the patients were examined in the clinic. In the entire study group, the state of the implant-osseous relationship around the installed orthopedic structures was satisfactory, regardless of the level of tissue keratization. An analysis of the radiographs was performed to determine the bone resorption level near the implants' neck (Table 2).

In general, in the study group, the level of bone resorption was 0.47±0.10 mm (M=0.45), the minimum value was 0.35 mm, and the maximum – 0.60 mm. In the first group, the depth of resorption was 0.46±0.10 mm (M=0.45), the minimum and maximum values were 0.35 and 0.60 mm, respectively. In the second group, the average level of sauserisation was 0.47±0.09 mm (M=0.45), the minimum and maximum values were also 0.35 and 0.60 mm, respectively. Applying comparative statistics methods did not reveal a significant difference between the two groups in the above indicator (p=0.93).

The analysis of the relative radiographic density of the jaw bone tissue in the areas of dental implantation before and one and a half years after the installation of dental implants did not reveal a significant difference in this indicator between the two groups of the study. Thus, in the first group of patients at the time of installation of dental implants, the average conditional radiographic density of bone tissue was 719.93±43.10 dHu (M=720.00), the minimum value was 645.00 dHu, and the maximum – 789.00 dHu (Table 3). After one and a half years, when approximately a year had passed since the beginning of the functioning of the dental implant as a support for the orthopedic structure, the average value of the indicator was 722.53±27.49 dHu (M=721.00), the minimum density was 690.00, and the maximum – 780.00 dHu. The comparative statistical tests did not reveal significant differences in bone density before implantation and one and a half years after the operatio. The comparative statistical tests also did not reveal any significant differences in the values before implantation and one and a half years after implantation. In group 2, the relative radiographic bone density level before implantation was 710.00±28.52 dHu (M=704.00), the minimum value was 678.00 dHu, and the maximum – 765.00 dHu. One and a half years after dental implantation, the values changed uncritically. The average density was 713.80±20.46 dHu (M=713.00), the minimum value was 692.00 dHu, and the maximum – 754 dHu.

DISCUSSION

Similarly, the same studies were performed on the conditional radiographic bone density values between two groups of patients - before the operation and one and a half years after it. The results also did not reveal statistically significant differences between the groups. Such data suggest that using both protocols for preparing the implant bed in the alveolar bone caused the same reactions from the bone tissue. The results largely coincide with the known works performed in many other countries. In the experimental work of J. Calvo-Guirado (2015) it was also shown that new hybrid protocols for preparing the implant bed (including slow, without water irrigation) in the alveolar bone tissue do not lead to significant changes in the primary stabilization of dental implants [10]. Experimental studies of bone regeneration in animals after the installation of screw-shaped intraosseous dental implants using different rapid preparation protocols by A. Sarendranath (2015) did not show significant differences in the quality of bone healing at the microscopic level [11]. Studies by H. Pellicer-Chover (2017) showed that in the clinic one year after the installation of dental implants using the rapid and "slow" protocols, there was no difference in marginal bone resorption, and the radiological structure of the surrounding bone tissue did not differ [12]. Comparative studies conducted by D. Simmons (2017) using a "soft" and standard implant bed preparation protocol showed that the implant survival rate for 1 year was 93.3% and did not depend on the preparation protocol, the level of radiographic bone resorption around the implant neck was approximately 0.5 mm and also did not differ in patients treated with different speed protocols [13]. Experimental studies by L. Witek (2019) showed that the osseodensification protocol enhances both primary and secondary stabilization (osseointegration) of tantalum intraosseous implants. Studies by A. Sultana (2020) in clinical conditions (6 months of patient follow-up) showed that osseodensification protocols have a generally favorable effect on dental implant outcomes [14]. Data from E. Pérez-Pevida (2020) on the results of using different preparation protocols for dental ceramic implants showed that with slow preparation, the levels of primary stabilization of the products are significantly higher [15]. Studies of the regenerative properties of bone tissue cells (A. Tabassum, 2020), which were collected during the preparation of the implant canal according to different protocols, showed that with a slow preparation speed, osteoblast-like cells had a higher potential for proliferation and differentiation than with a standard protocol [16]. The study by J. Bernabeu-Mira (2021) showed that the use of "slow" bone tissue preparation protocols, including osseodensification techniques, do not lead to a significant difference in the rate and intensity of wear of surgical burs for bone preparation, marginal bone resorption (sauserisation), the level of implantation success and the histomorphological structure of bone tissue after the onset of osseointegration. A clinical randomized trial of different speed protocols for alveolar bone preparation did not reveal a significant difference in the rates of marginal bone resorption 3 months after placement [7]. There were also no differences in the level of implantation success (A. Tabassum, 2021) [17]. A systematic review by X. Yu (2022) shows that three optional techniques for implant bed preparation (osseodensification, piezotomy, and the use of osteotomes) lead to a higher level of primary stabilization of dental implants [18]. A systematic review by C. Sigilião Celles (2023) indicated that no statistically significant difference was observed in the mechanical fixation of dental implants in the alveolar bone when using different high-speed implant bed preparation protocols [19]. S. Soler-Alcaraz (2023) conducted fractal measurements of bone regeneration after the use of two different speed protocols for implant bed preparation showed that bone tissue regenerated without significant differences, and the different speed protocols used did not affect the quality of implant osseointegration [20].

CONCLUSIONS

Using a slow protocol for implant channel preparation in clinical settings revealed that this approach, in addition to reducing bone tissue loss due to bone beam microabfractions and attrition, causes certain densification of bone tissue due to its condensation. The statistical calculations (comparative statistical tests) indicated the presence of a statistically significant difference between the torque values in the two groups. The slow bone tissue preparation protocol used in the clinic in the long term, one year after loading the implant with a superstructure, did not cause significant changes in the structure of the bone tissue compared to the standard protocol for preparation of the implant bed (as evidenced by the analysis of the relative radiographic density of the jaw bone tissue in the area of surgical intervention before and one and a half years after the installation of dental implants. Observation of the bone tissue resorption level in the implant's cervical area one year after the installation of the orthopedic structure (sauserisation) did not reveal statistically significant differences between the two groups of patients. Clinically, the bone tissue around the installed orthopedic structures was satisfactory in the entire study group, regardless of the level of tissue keratization. Such data may indicate that using a slow bone tissue preparation protocol without water cooling at the stage of implant bed formation allows for achieving clinical and radiographic treatment results that are identical to standard high-speed protocol with water cooling.

REFERENCES

1. Goncharuk-Khomyn M, Keniuk A. Evaluation of Peri-Implant Bone Reduction Levels from Superimposition Perspective: Pilot Study among Ukrainian Implantology Practice. Pesquisa Brasileira em Odontopediatria e Clinica Integrada. 2018;18(1):e3856.
2. Tsuperiak SS, Mochalov IO. Renthenolohichni pokaznyky shchil'nosti kistkovoyi tkanyny pislya zastosuvannya riznykh khirurhichnykh protokoliv dental'noyi implantatsiyi. [The Indicators of X-ray Density of Bone Tissue after using the Different Surgical Protocols of Dental Implantation]. Suchasna stomatolohiya. 2023;1–2:46–54. doi:10.33295/1992576X20231246. (Ukrainian) DOI
3. Tsuperyak S, Mochalov I. Eksperymental' asessment of tkhe bone kavity neatynh at dyferent speeds dyurinh preparation for dental' implantation. [Experimental assessment of the bone cavity heating at different speeds during preparation for dental implantation]. Eastern Ukrainian Medical Journal. 2023;11(1):53–62. doi:10.21272/eumj. (Ukrainian) DOI
4. Hsu JT, Wu AY, Fuh LJ, Huang HL. Effects of implant length and 3D bone to implant contact on initial stabilities of dental implant: a microcomputed tomography study. BMC Oral Health. 2017;17(1):132. doi: 10.1186/s1290301704221. DOI
5. Huwais S, Meyer E. A novel osseous densification approach in implant osteotomy preparation to increase biomechanical primary stability, bone mineral density, and bone-to-implant contact. Int J Oral Maxillofac Implants. 2017;32:27–36. doi: 10.11607/jomi.4817. DOI
6. Bandela V, Shetty N, Munagapati B et al. Comparative Evaluation of Osseodensification Versus Conventional Osteotomy Technique on Dental Implant Primary Stability: An Ex Vivo Study. Cureus. 2022;14(10):e30843. doi: 10.7759/cureus.30843. DOI
7. Bernabeu-Mira JC, Soto-Peñaloza D, Peñarrocha-Diago M et al. Low-speed drilling without irrigation versus conventional drilling for dental implant osteotomy preparation: a systematic review. Clin Oral Investig. 2021;25(7):4251–67. doi: 10.1007/s0078402103939z. DOI
8. Frizzera F, Spin-Neto R, Padilha V. Effect of osseodensification on the increase in ridge thickness and the prevention of buccal peri-implant defects: an in vitro randomized split mouth pilot study. BMC Oral Health. 2022;22(1):233. doi:10.1186/s1290302202242x. DOI
9. Alifarag AM, Lopez CD, Neiva RF et al. A temporal osseointegration: early biomechanical stability through osseodensification. J Orthop Res. 2018;36(9): 2516–23. doi: 10.1002/jor.23893. DOI
10. Calvo-Guirado JL, Delgado-Peña J, Maté-Sánchez JE et al. Novel hybrid drilling protocol: evaluation for the implant healing thermal changes, crestal bone loss, and bone-to-implant contact. Clin Oral Implants Res. 2015;26(7):753–60. doi: 10.1111/clr.12341. DOI
11. Sarendranath A, Khan R, Tovar N et al. Effect of low speed drilling on osseointegration using simplified drilling procedures. Br J Oral Maxillofac Surg. 2015;53(6):550–6. doi: 10.1016/j.bjoms.2015.03.010. DOI
12. Pellicer-Chover H, Peñarrocha-Oltra D, Aloy-Prosper A et al. Comparison of peri-implant bone loss between conventional drilling with irrigation versus low-speed drilling without irrigation. Med Oral Patol Oral Cir Bucal. 2017;22(6):730–6. doi: 10.4317/medoral.21694. DOI
13. Simmons DE, Maney P, Teitelbaum AG et al. Comparative evaluation of the stability of two different dental implant designs and surgical protocols a pilot study. Int J Implant Dent. 2017;3(1):16. doi: 10.1186/s4072901700782. DOI
14. Sultana A, Makkar S, Saxena D et al. To compare the stability and crestal bone loss of implants placed using osseodensification and traditional drilling protocol: A clinic-radiographical study. J Indian Prosthodont Soc. 2020;20(1):45–51. doi: 10.4103/jips.jips_133_19. DOI
15. Pérez-Pevida E, Cherro R, Camps-Font O et al. Effects of Drilling Protocol and Bone Density on the Stability of Implants According to Different Macrogeometries of the Implant Used: Results of an In Vitro Study. Int J Oral Maxillofac Implants. 2020;35(5):955–64. doi: 10.11607/jomi.8176. DOI
16. Tabassum A, Wismeijer D, Hogervorst J et al. Comparison of Proliferation and Differentiation of Human Osteoblast-like Cells Harvested During Implant Osteotomy Preparation Using Two Different Drilling Protocols. Int J Oral Maxillofac Implants. 2020;35(1):141–9. doi: 10.11607/jomi.7648. DOI
17. Tabassum A. Radiographic comparisons of crestal bone levels around implants placed with low-speed drilling and standard drilling protocols: Preliminary results. Saudi Dent J. 2021;33(8):965–71. doi: 10.1016/j.sdentj.2021.08.003. DOI
18. Yu X, Chang C, Guo W et al. Primary implant stability based on alternative site preparation techniques: A systematic review and meta-analysis. Clin Implant Dent Relat Res. 2022;24(5):580–90. doi: 10.1111/cid.13127. DOI
19. Sigilião Celles CA, Ferreira I, Valente MDLDC et al. Osseointegration in relation to drilling speed in the preparation of dental implants sites: A systematic review. J Prosthet Dent. 2025;133(2):394-401. doi:10.1016/j.prosdent.2023.03.004. DOI
20. Soler-Alcaraz S, Guerrero-Sánchez Y, Pérez-Sayáns M et al. Evaluation of Change in Radiographic Fractal Dimension around Dental Implants Placed with Low-Speed Drilling and Standard Drilling Protocols. J Clin Med. 2023; 12(6):2244. doi: 10.3390/jcm12062244. DOI

Title and number of scientific project (grant): "The improvement and clinical evaluation of methods for the diagnosis, treatment and prevention of dental diseases in adults and children" (state registration number 0123U100414).

CONFLICT OF INTEREST
The Authors declare no conflict of interest

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RECEIVED: 10.11.2024
ACCEPTED: 26.03.2025