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Surgery-related factors affecting the stability of orthodontic mini implants screwed in alveolar process interdental spaces: a systematic literature review

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SUMMARY

The ambiguous results of scientific researches on surgical factors affecting the stability of mini implants (MI) impels the physicians to constantly analyze this problem. The objective of this article was to conduct a systematic literature review about surgery related factors affecting the stability of MI screwed in alveolar process buccal surface between the second premolar and first molar roots based on peer reviewed publications of 2009-2015.

The Cochrane and PRISMA references were used while searching for scientific literature. Two data bases and scientific publications were browsed in the Lithuanian University of Health Sciences library. Criteria for article selection were: 1) research in which surgical factors affecting MI stability were analyzed, 2) research in which stability of MI screwed in alveolar process between adjacent teeth roots was analyzed, 3) research in which MI stability was analyzed in clinical practice, 4) articles which were published in 2009-2015. Selected articles were evaluated in accordance with methodical quality.

13 articles met the selection criteria of the research. 2652 MI screwed in 1205 people jawbones' alveolar processes were analyzed in selected articles. The MI success rate was 87.7-97%. Root proximity was identified to be the main determinant of all MI success influencing surgical factors (MI and root contact determined a 9-26.7% failure rate). The results of this article confirm the sufficient MI stability rate in clinical practice and specifies root proximity as the main surgical factor affecting the MI stability.

Key words: mini-implant, temporary anchorage device, stability, success, failure.

INTRODUCTION

Various temporary skeletal anchorage devices have been successfully used in orthodontics for two decades (1). Smaller than 2.0 mm in diameter mini implants (MI) are one of the most popular temporary anchorage devices used in orthodontics (2). In comparison to other skeletal anchorage methods, MI have been recognized to be especially effective, as their success rate is averagely 90% (1-13). The advantages of MI are various jawbone locations where they can be screwed in, the decreased necessity of patient's collaboration during treatment, lower negative effect on teeth, price, minimal surgical intervention, practitioner's and patient's comfort and clinical efficiency (14, 15). Due to MI anchorage the orthodontist can preserve up to 2.4 mm more space in dental arches than with other traditional anchorage devices (16, 17). These are the reasons why MI are widely used in difficult orthodontic situations for asymmetric treatment in all three dimensions and as an alternative for orthognathic surgery (18).

The most popular MI insertion sites are the interdental spaces between the first molar and second premolar roots (19-24). Rodriguez *et al.* (2) specify the success rate of such MI to be 87.8% and the majority of failures is related to surgical procedures (78.45%) and orthodontic treatment (19.83%). On the other hand, based on recent decade scientific researches, MI stability is determined by various factors acting simultaneously, therefore it is difficult to evaluate their individual influence on MI stability (21, 25-30). Three main groups of MI stability affecting factors have been established by various authors: 1) surgery-related, 2) orthodontic-

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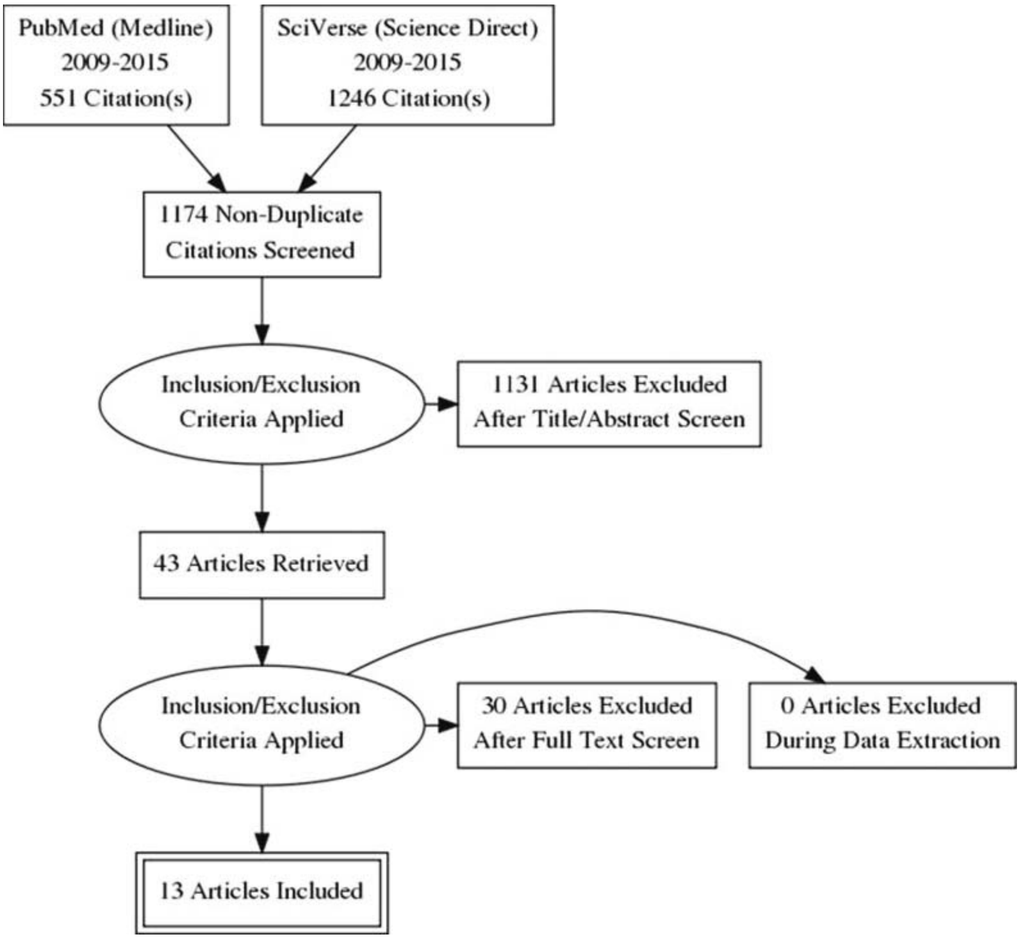

Fig. 1. The PRISMA Flow Diagram

related, 3) patient-related factors. Due to the latest systematic literature reviews and meta-analyses, surgery related factors have the main impact on MI stability (success, failure) (1, 2, 31, 32). This group of factors include the shape, type, construction, diameter, length and surface manufacturing of MI, shape of the thread, MI insertion angle and torque, type of implantation, experience of practitioner, MI insertion site (maxilla or mandible, which interdental space, the amount of cortical and trabecular bone, type of soft tissue) and iatrogenic complications. More and more scientific researches about these MI stability affecting surgery related factors have been published and their results are mostly contradictory. Therefore, the scientific society, practitioners and manufacturers are being forced to seek for comprehensive and scientifically reasoned researches, which would contribute in treatment planning and lower failure rates. Accordingly, the objective of this article was to conduct a systematic literature review about surgery related factors affecting the stability of MI screwed in alveolar process buccal surface between the second premolar and first molar roots based on peer reviewed publications of 2009-2015.

MATERIAL AND METHODS

The Cochrane Handbook for Systematic Reviews of Interventions and the PRISMA statement guidelines were used as the framework for this article. PubMed (Medline) and SciVerse (Science Direct) data bases were reviewed for articles published in English in 2009-2015. The key words and their combinations used for articles' search were: mini-implant, miniscrew, ortho-implant, orthodontic anchorage screw, temporary anchorage device, temporary skeletal anchorage device, orthodontics, mini implant, mini screw, surgical, stability, success, failure, rate, risk factors.

The article selection criteria were determined according to the object of research, type and method of study, sample size and analysis of the results:

1. Articles analyzing the influence of surgery related factors on the stability of MI screwed in alveolar process interdental spaces;
2. Research on MI stability during orthodontic treatment;
3. Sample size ≥40 MI;
4. The MI diameter ≤2.0 mm;
5. Researches of MI which were used as an anchorage for ≥12 weeks or until the orthodontic treatment ending;
6. Articles published in English in peer reviewed journals in 2009-2015;
7. No sex or age restrictions.

Articles exclusion criteria were:

1. Single clinical case reports;
2. *In vitro* studies;
3. Finite element analysis studies;
4. Animal studies;
5. Review articles.

All titles and summaries of found publications were reviewed in order to exclude all inadequate articles. The full versions of remaining, possibly appropriate, articles were reviewed. The full texts of articles', which eligibility could not be evaluated by reviewing their summaries, were read on purpose to avoid incorrect exclusion. The process of articles' selection is presented in the PRISMA diagram (Figure 1).

All inclusion criteria matching articles were analyzed and their quality was evaluated based on modified Feldmann and Bondemark (33) suggested method under five criteria: 1) sample size, 2) research method, 3) research object description, 4) research technique and 5) study design (Table 1). After qualitatively evaluating all articles, they were divided into two categories: of high (8-10 points) (3-9, 11, 34-36) and medium (6-7 points) (10, 12) quality.

RESULTS AND DISCUSSION

1797 articles were found after primary electronic databases search. The search results are shown in the PRISMA articles' search flow diagram (Figure 1). 623 articles were rejected because of repeating in the databases. The remaining 1174 articles' summaries were analyzed in detail. The articles which had not conformed the inclusion requirements were rejected and 43 articles' full texts were downloaded and read. After applying the inclusion and exclusion criteria only 13 articles were left. These articles were evaluated qualitatively.

Table 1. The criteria of articles' qualitative evaluation

Analyzed criteria	Description	Evaluation
Sample size	The quantity of analyzed MI	0-10 – 0 points; 11-20 – 1 point; ≥21 – 2 points
Research method	Research method used for MI insertion site analysis	None – 0 points; Radiological 2D – 1 point; Radiological 3D, histological analysis or scanning electron microscopy – 2 points
Research object description	The quantity of researched individuals	0-5 – 0 points; 6-10 – 1 point; ≥11 – 2 points
Research technique	Clinical examination, the use of objective measuring device (Periotest, torque screwdriver, orthodontic tension gauge)	Clinical examination – 1 point; The use of objective measuring device – 2 points
Study design	Controlled, uncontrolled study	Uncontrolled study – 1 point; controlled study – 2 points

Table 2. Analyzed researches' results

Article	Diameter (mm)	Length (MM)	Patients sample	Patients' average age (years)	MI sample, self-tapping (ST)/self-drilling (SD)	The number of failures	Success rate, %	MI loading duration (months)
Shigeeda (3)	1.6	8	58	24.4±8.5	165, ST	8	95	≥6
Min *et al.* (4)	1.2-1.3	8	94	19.36±5.66	172, SD	16	90.7	12, or until orthodontic treatment end
Jung *et al.* (5)	1.2-1.3	8	130	19.24±6.66	228 SD	28	87.7	12, or until orthodontic treatment end
Shinohara *et al.* (6)	1.6	8	50	21.8±5.7	147, ST	8	94.6	≥3
Manni *et al.* (7)	1.3; 1.5	9;11	132	Women 25.9±11.6; men 19.6±10.1	300, ST	57	81	11.63
Lai *et al.* (8)	1.6-2	8-10	129	20.2±9.4	266, n/d	8	97	≥3
Sharma *et al.* (9)	1.3	8	73	22.45±6	139, n/d	17	87,8	8.96±4.8
Lim *et al.* (10)	1.6; 1.8	6-8;10	168	23±8.7	407, n/d	28	93,1	≥3
Janson *et al.* (11)	1.5	7	21	16.99±5.08	40, SD	4	90	9.22±3.12
Wu *et al.* (12)	1.2-2	7;8;10-12	166	26.5±8.9	414, SD	42	89,9	≥6
Watanabe *et al.* (34)	1.4	5;6;8	107	21	190, ST	N/d	N/d	≥3
Motoyoshi *et al.* (35)	1.6	8	52	26.1±8.4	134, ST	N/d	N/d	12, or until orthodontic treatment end
Kim *et al.* (36)	1.8	8.5	25	26	50 ST	N/d	N/d	15.3

The randomized controlled trials of MI used during orthodontic treatment were analyzed in all 13 publications. MI of 9 different manufacturers and 2 types (self-tapping and self-drilling) which were threaded in 1205 patients' upper and lower jaws' alveolar process buccal surface between roots of the first molar and second premolar were analyzed. 2652 MI 1.2-2.0 mm in diameter and 5.0-12.0 mm in length were analyzed. Based on the results of ten articles' (3-12) in which failure of MI was studied, 216 (9.48%) from 2278 MI were unsuccessful (Table 2).

The sample of analyzed MI was more than 100 MI in the majority of articles (3-10, 12, 34, 35) and only in two articles less MI were used (40 and 50 MI) (11, 36). The number of patients included into researches was 21-168. The analyzed MI were used for anchorage for at least 3 months.

The MI stability/success/failure affecting factors were analyzed in all articles, however, not all authors had given the definition of a "successful" MI (Table 3). The „success" was described only in six articles (3-5, 7, 9, 12). On the basis of given descriptions, a successful MI is that which performs its' function of a temporal skeletal anchorage device for a certain period of time (6-12 months) or during all orthodontic treatment and any notable or progressive mobility and no surrounding soft tissue inflammation or other pathologies are found.

The analyzed surgery related factors affecting MI stability were: jaw (maxilla, mandible) (6-10, 12, 34, 35), side of MI insertion (left, right) (4, 5, 7-9, 12), cortical bone thickness and bone density (4, 5, 8, 34, 35), type of soft tissue (keratinized, non-keratinized, mucogingival junction) (7-11), insertion angle in vertical and horizontal planes (5, 6, 34, 36) and insertion torque (35, 36), MI proximity to adjacent roots (3-7, 11, 34, 36) and practitioner's experience (10, 12) (Table 3).

None of the authors analyzed MI insertion site diagnostics and clinical selection criteria in detail. The importance of MI diameter selection for MI stability was analyzed in only one article (12). The authors specified that MI of 1.4 mm diameter or smaller in maxilla and MI wider than 1.4 mm in mandible had statistically significantly higher stability (Table 3). The authors have not found any influence of MI length and type on success rate.

Different diagnostics methods were applied for MI insertion site analysis in the researches. Only clinical examination was applied in four researches (8-10, 12), radiological 2D examination was applied in two researches (7, 11) and in the remaining seven studies radiological 3D – computed tomography or cone beam computed tomography (CBCT) were applied (3-6, 34-36) (Table 3). There were several additional clinical examination methods applied for MI stability analysis in four articles (3, 11, 35, 36): the Periotest device (Medizintechnik Gulden, Bensheim, Germany), orthodontic tension gauge (Correx series 040-712-00, Dentaurum Orthodontics, Ispringen, Germany) and torque screwdriver (N2DPSK, Nakamura, Tokyo, Japan).

The success rate of MI was assessed in the analyzed articles. On the basis of the researches' results, the success rate of MI used during orthodontic treatment was from 87.7% to 97%, though the success rate was not presented in two articles (34, 35). In seven articles the success rate of MI was analyzed in maxilla and mandible (6-10, 12, 34). The MI success rate in maxilla ranged from 86.9% to 97.2% and in mandible – from 70.69% to 93.7%. In five researches (6-8, 12, 34) the success rate of MI was higher in maxilla than mandible; in two articles – the results were the opposite (Table 3).

The influence of MI implantation site on success rate was analyzed in six researches (4, 5, 7-9, 12). Even though the success rates on the left jaw side were higher, but there had not been found any statistically significant difference between the jaw sides.

The authors of three researches (4, 5, 34) had been analyzing the influence of cortical bone layer on MI success rate. It was found out that the thickness of cortical bone is not the major factor influencing the stability of MI. Min *et al.* (4) declared that a 0.1-mm increase in the cortical bone thickness increased the success rate only 0.366 times ($P>0.05$), while based on Jung *et al.* (5), such cortical bone thickening increased the success rate 32.2 times ($P>0.05$) (Table 3).

The influence of bone quality in MI insertion site on the MI success rate was analyzed by Lai *et al.* (8). Based on the quality of bone classification by Lekholm and Zarb (37), Lai *et al.* (8) distinguished four categories: Q1 – bone in which almost the entire bone is composed of homogenous compact bone, Q2 – bone in which a thick layer of compact bone surrounds a core of dense trabecular bone, Q3 – bone in which a thin layer of cortical bone surrounds a core of dense trabecular bone, Q4 – bone characterized as a thin layer of cortical bone surrounding a core of low density trabecular bone of poor strength. On the basis of the research results, a successful treatment with MI may be expected if the MI is threaded in a high quality bone tissue: the MI success rates in Q1-Q3 groups were 100%, 98.7% and 94.8% respectively, while in Q4 group – only 66.7% (Table 3). Watanabe *et al.* (34)

were analyzing the interface between bone density and MI success rate and no statistically significant difference was detected (Table 3).

The influence of MI proximity to adjacent teeth roots on MI success rate was analyzed in eight researches (3-7, 11, 34, 36). The results of all these researches declare the statistically significant difference between successful and unsuccessful MI groups: MI without contacts with adjacent teeth roots had higher success rates (Table 3). Three researches' authors emphasized the MI proximity to adjacent roots as the major MI success rate affecting factor (5, 11, 36). Watanabe *et al.* (34) classified the periapical radiographs into four groups (A-D) in

Table 2. Analyzed researches' results *(continued on next page)*

Article	„Successful MI" definition description	Diagnostics method	Results
Shigeeda (3)	A stable MI which withstands orthodontic loading for ≥6 months with no mobility	CBCT; Periotest	Failure rate without/with MI contact with dental root in maxilla: 1.7%/10.5%; in mandible: 1.4%/25.0%. Periotest value in maxilla: A* – 1.4±3.7, B – 1.6±2.1, C** – 1.5±2.5; in mandible: A* – 2.9±2.6, B – 3.2±2.2, C** – 5.6±3.8 (*, **: P<0.05). MI screwed in mandible had a higher mobility than in maxilla.
Min *et al.* (4)	MI remained in bone and was an appropriate skeletal anchorage for 1 year of orthodontic treatment	CBCT	16/172 (9.3%) MI had contacts with dental roots. 11/16 (68.8%) of MI with dental roots contacts were unsuccessful. A 0.1-mm increase in MI proximity to dental roots and cortical bone thickness increased the success rate 69.6448 times (P<0.05) and 0.3660 times (P>0.05) respectively. The MI proximity to dental roots had a higher influence on the increase of success rate. Increasing the MI proximity to adjacent dental roots, the success rate is increasing statistically significantly.
Jung *et al.* (5)	MI remained in bone and was an appropriate skeletal anchorage for 1 year of orthodontic treatment	CBCT	The average vertical and horizontal MI insertion angle, MI proximity to adjacent roots and cortical bone thickness in success and failure groups were: 73.75° and 75.93°; 97.11° and 96.65°; 0.49 mm and 0.11 mm; 1.17 mm and 0.97 mm respectively. A 0.1-mm increase in MI proximity to dental roots and cortical bone thickness increased the success rate 25.27 times (P<0.05) and 32.2 times (P>0.05) respectively. MI success affecting factors in a descending order: MI proximity to adjacent roots, cortical bone thickness, insertion angle in horizontal and vertical planes.
Shinohara *et al.* (6)	N/d	CBCT	Averagely 20% of MI had contacts with dental roots. The average MI proximity to dental roots was 0.6-1.0 mm. The average vertical MI leaning in maxilla: 48.3°-50.4°; in mandible: 57.5°-63.3°. A statistically significantly higher rate of MI contacts to adjacent distal teeth were identified in the right side of maxilla. 2 MI of 118 with no contacts with adjacent roots were unsuccessful (1.7%). 6/29 MI with contacts to adjacent roots were unsuccessful (20.7%).
Manni *et al.* (7)	Any surrounding soft tissue inflammation or MI mobility is detected	Radiological 2D	57 MI were unsuccessful (19%). 35 MI (61.4%) were removed due to mobility; 4 (7.1%) – due to acute post-operative inflammation; 18 (31.6%) – were lost itself. Lower diameter MI (1.3 mm) had a statistically significantly higher success rate than 1.5 mm diameter MI (9 mm and 11 mm length): 88.3%, 75.5% and 79.3% respectively. No statistically significant relations between MI relation to adjacent root (coronal, middle or apical third) was detected.
Lai *et al.* (8)	N/d	Clinical examination	Analyzed MI diameter/length (mm): 1) 1.6/8.0, 2) 1.6/10.0, 3) 2.0/10.0 (the success rates: 94.8%, 95.2% and 97.0% respectively (P>0.05)). MI screwed in higher quality bone tissue (Q1, Q2 and Q3) had statistically significantly higher success rates than MI screwed in poor quality bone (Q4): 100%, 98.7%, 94.8% and 66.7% respectively. No statistically significant relation between success and failure groups due to MI diameter and length, patient's sex and age, malocclusion type and MI insertion side was detected.

their research according to the proximity of the MI and the root (Figure 2). The authors had also done the CBCT examination of the MI proximity to adjacent teeth roots. The CBCT radiographs had been classified into four types according to the proximity of MI's three points (apex, middle and neck at alveolar bone level) to the root: A – all three points >0.7 mm from the root surface, B – only the apex point ≤0.7 mm from the root surface, C – only the middle point ≤0.7 mm from the root surface, D – two points ≤0.7 mm from the root surface. The authors had declared that it was difficult to differentiate the root surface from the MI when the distance was ≤0.7 mm (Figure 3). The authors compared the MI suc-

Table 2. Analyzed researches' results *(continued from previous page)*

Article	„Successful MI" definition description	Diagnostics method	Results
Sharma *et al.* (9)	An unsuccessful MI: was lost itself, a notable mobility was observed and a repeated MI insertion was necessary, or soft tissue pathological changes or pain was identified	Clinical examination	MI survival period was 8.96±4.8 months. Poor oral hygiene, MI insertion in mobile gingiva and MI surrounding soft tissue inflammation lead to MI failure.
Lim *et al.* (10)	N/d	Clinical examination	MI, which were screwed in by more experienced had a 7.1% higher success rate (97.5%). No statistically significant difference between groups of patients' sex and age, jaw, oral mucosa type, MI length and diameter was detected. MI primary stability depends on the insertion site and practitioner's experience.
Janson *et al.* (11)	N/d	Bitewing radiograph; orthodontic tension gauge	The analyzed MI were divided into two groups according to septum width: 1) ≤ 3mm (20 MI), 2) >3 mm (20 MI). The MI proximity to dental roots was statistically significantly lower in group 1. MI proximity to the root did not have any statistically significant relation with the mobility degree. Although, due to the minimal proximity between MI and the root the periodontal ligament can be damaged during MI insertion, which may increase MI failure rate. The interdental septum width did not have any influence on MI success rate. A small MI proximity to the root had the major influence on MI success rate.
Wu *et al.* (12)	The MI which remained as an orthodontic anchorage for 6	Clinical examination	The failure rate in maxilla/mandible when MI diameter ≤1.4 mm: 8.4%/16.3% (P=0,036); when MI diameter >1.4 mm: 13.2%/2.7% (P=0,085). No statistically significant association between the MI failure rate and patient's age, sex and MI insertion site was detected. The failure rate of the MI inserted by the same practitioners decreased from 25% to 7.9% from 2002 to 2006.
Watanabe *et al.* (34)	N/d	Periapical radiographs; CBCT	The success rates were measured after periapical radiographs' analysis: A – 96.08%, B – 66.67%, C – 88.89%, D – 78.57%. The success rates were measured after CBCT radiographs analysis: A – 94.5%, B – 62.5%, C – 50.0%, D – 14.29%. The average MI insertion angle in maxilla and mandible were: 42-43° and 45-57° respectively. No statistically significant association between MI insertion angle, bone density and success and failure groups was detected.
Motoyoshi *et al.* (35)	N/d	CBCT; Torque screwdriver	No statistically significant difference between MI insertion and removal torque due to cortical bone thickness was detected. A statistically significant association between cortical bone thickness and MI insertion torque in maxilla was detected (r=0.392, P<0.05).
Kim *et al.* (36)	N/d	CBCT; digital torque screwdriver	Based on MI proximity to dental roots or maxillary sinus penetration, the groups of analyzed MI were: 1 – MI showed root proximity on one side, 2 – MI showed root proximity on both sides, 3 – MI had no root contact but penetrated the sinus, 4 – MI had both root proximity and sinus penetration. The majority of MI and root contacts was detected in group 1. Multiple MI contacts with adjacent roots with maxillary sinus penetration and without primary stability had the major impact on MI failure. MI and contacting root surface area had impact on MI stability.

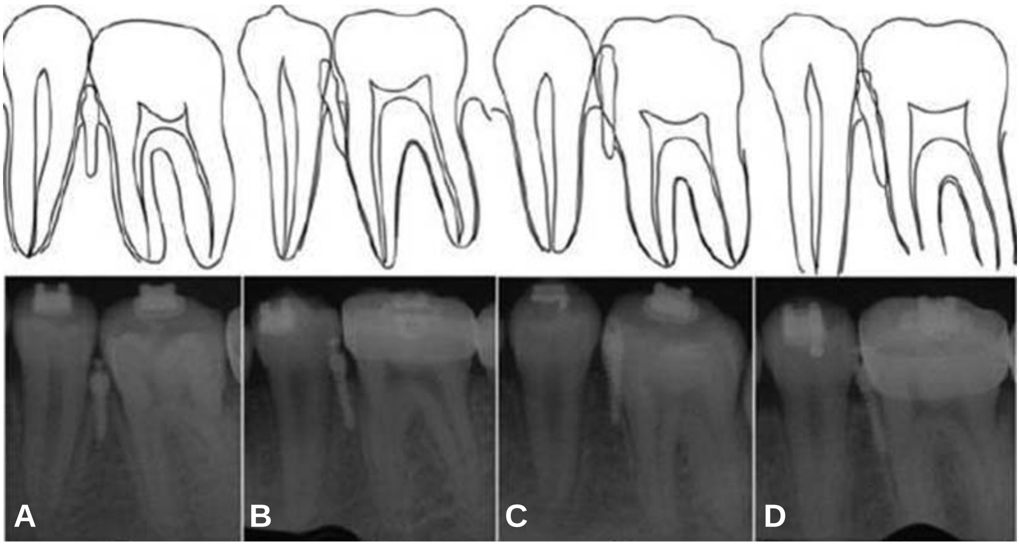

Fig. 2. Classification of the periapical radiographs from A to D according to the proximity of the mini-implant and the root: A – the mini-implant was completely separated from the root surface, B – only apex of mini-implant was in contact with the root surface, C – the neck at alveolar bone level or middle part of the mini-implant was in contact, and the apex was separated from the root surface, D – the entire body of the mini-implant was in contact with the root surface (Watanabe et al (34)).

cess rates in different groups between analyzed periapical and CBCT radiographs. The success rate results of both analysis methods were the highest in group A and decreased in groups B, C and D respectively. The success rates were lower in CBCT radiographs group (Table 3). Shigeeda (3) also analyzed the CBCT radiographs to evaluate the influence of MI proximity to adjacent teeth roots on MI success rate (Figure 4). The MI failure rates in groups A-C were evaluated and the results were 1.5%, 9% and 26.7% respectively. Consequently, multiple MI and root surface contacts considerably reduces the MI success rate (Table 3).

The influence of MI insertion angle on the success rate was analyzed in four researches (5, 6, 34, 36). However, there was no statistically significant association detected (Table 3).

The practitioner's experience influence on MI success rate was analyzed in two researches (10, 12). Lim *et al.* (10) estimated the MI success rates of practitioners with lower and higher MI insertion experience (< 20 and ≥ 20 inserted MI respectively). The results of MI success rate were 7.1% higher in more experienced practitioners' group (Table 3). Wu *et al.* (12) also determined the association between practitioner's experience and MI failure rate, which decreased from 25% to 7.9% from year 2002-2006 in their research analyzed practitioners' inserted MI groups (Table 3). On the basis of these two researches' results, it can be concluded that one of the surgery related factors affecting MI stability is practitioner's experience.

The influence of oral mucosa type on MI success rate was analyzed in five researches (7-11). In three articles (7-9) there was a statistically significant association between the mucosa type and MI success rate determined: MI inserted in keratinized gingiva had higher success rates than MI inserted in non-keratinized mucosa. However, in two articles there was no statistically significant association between the type of oral mucosa and MI success rate determined (10, 11) (Table 3).

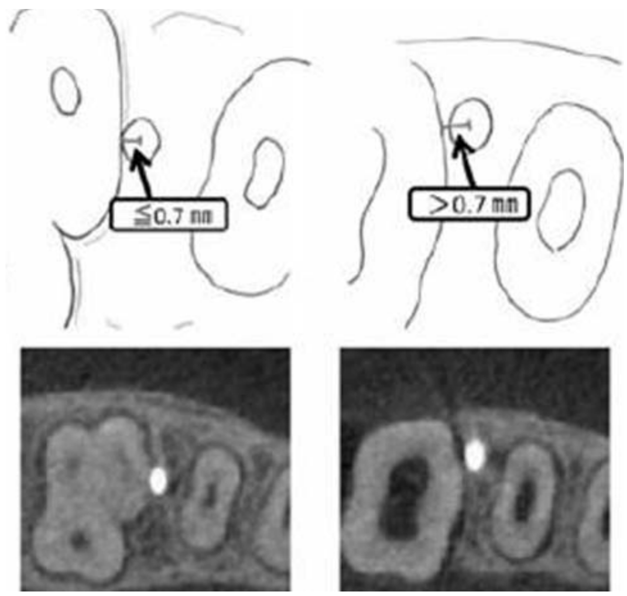

Fig. 3. Scheme and cone beam computed tomography scans image of the line between the root surface and the mini-implant (Watanabe (34))

Motoyoshi *et al.* (35) researched the influence of MI insertion torque on MI primary and secondary stability. On the authors' recommendations, 4 N torque is sufficient for machine MI insertion. The MI insertion torque for older patients with thinner cortical bone in maxilla should be lower than in mandible and younger patients (Table 3).

CONCLUSIONS

1. This systematic literature review's results confirm the sufficient success rate (87.7-

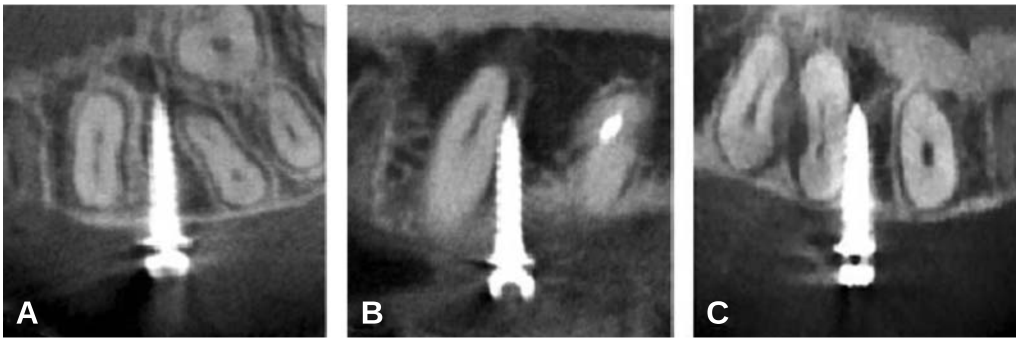

Fig. 3. Root proximity categories used in Shigeeda's (3) research: A – no contact between the mini-implant and root, B – one point of contact between the root and apex or body of the mini-implant, C – two or more contacts between the root and mini-implant.

97%) of MI, inserted in buccal surface of jaw's alveolar process between the first molar and second premolar roots and allows to assess MI as a reliable and beneficial anchorage device.

2. On the basis of analyzed researches' results, the MI stability affecting surgery related factors are: the jaw (success rates in maxilla: 86.9-97.2%; in mandible: 70.69-93.7%), MI proximity to adjacent teeth roots (a contact with root determined a 9.0-26.7% failure rate), bone quality (the success rate of MI inserted in Q1-Q3 quality bone was 94.8-100%), oral mucosa type (MI success rate in keratinized gingiva: 85.4-96.2%, in non-keratinized gingiva: 62.5-75.2%) and practitioner's experience (more experienced practitioners' inserted MI had 7.1-17.1% higher success rates).
3. Further controlled clinical random samples researches with strictly defined criteria for MI characteristics, insertion methods and site, tracing, evaluation and performed by experienced clinicians should be carried out.
4. Several definitions of MI "success", "failure", "stability" exist in scientific literature. In our opinion, these definitions should be unified to achieve more homogeneity in scientific researches. We suggest to call a MI "successful", which remains stable, functions for all orthodontic treatment duration, with no surrounding soft tissue inflammation signs or other undesirable consequences.
5. Due to huge data heterogeneity, meta-analyses instead of systematic literature reviews should be chosen to summarize the factors affecting MI stability.

STATEMENT OF CONFLICT OF INTEREST

The authors state no conflict of interest.

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