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RESEARCH ARTICLE

THE INFLUENCE OF VARIOUS FACTORS ON THE SUCCESS OF ORTHODONTIC MINISCREWS: RETROSPECTIVE STUDY

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Abstract

Objective: To assess the correlation between influencing factors such as patient age, gender, insertion side, and miniscrew length with the success and failure rates of orthodontic miniscrews.
Materials and Methods:A total of 142 miniscrews were placed in five different zones in 72 patients. Three different lengths of miniscrews were used. Patients were divided into three different groups according to their age.
Results: The highest success rate was observed in the upper right quadrant, while the lowest success rate was recorded in the lower left quadrant. Miniscrews with an 8mm length exhibited the highest success rate. Patients in group 1 showed the highest success rate; however, the chi-square test revealed no correlation with the success/failure rate of miniscrews.
Additionally, the success rate of miniscrews placed in female patients was higher than in male patients, with a significant correlation between gender and the success/failure rate of miniscrews.
Our findings highlight that the placement location (anterior palate vs. intraradicular) does not significantly impact the success rate of miniscrews. Instead, patient gender appears to be a more critical factor influencing miniscrew survival.
Conclusion: This retrospective study revealed that miniscrew success rate is not significantly influenced by insertion side, miniscrew length, or gender, but rather by patient age. Interradicular placement of miniscrews exhibits a success rate comparable to that of miniscrews placed in the anterior palate.
This knowledge can help orthodontists make more informed decisions about miniscrew placement and patient selection, ultimately improving treatment outcomes and advancing orthodontic practice.

Keywords: Key words: Orthodontic Miniscrew, Anchorage, Success rate, Stability

Introduction

Anchorage often plays a crucial and sometimes game-changing role in orthodontics. Prior to the invention of miniscrews, orthodontists had to rely on complicated and inconvenient appliances, which were not always well-received by patients. Due to the lack of patient compliance, the effectiveness of these methods was often minimal, resulting in alterations to the initial treatment plan.

Miniscrews, as anchorage devices, can be applied in various zones of the oral cavity, including interradicular sites in both the buccal and palatal regions, as well as extraradicular sites such as the infrazygomatic crest, buccal shelf, anterior palate, and ramus.

Different researchers have evaluated the success and failure rates of miniscrews in various regions. Topouzelis et al., stated that the overall success rate of miniscrews was 90.2%, with success rates of 93% in the retromolar triangle and 89% in the anterior palate, respectively[1]. Alharbi et al., in their systematic review, estimated the miniscrew failure rate to be 13.5%. The failure rate of short miniscrews was 12.7%, which is slightly higher than the failure rate of long miniscrews at 8.3%[2].

The stability of miniscrews can be influenced by various factors, including diameter, length, insertion torque, patient age and gender, poor oral hygiene, and insertion site.

In their study, G. Maino et al. reported that the mean overall success rate of the implants was 91.4%. They found that the length and shape of the miniscrews significantly influenced the success rate, while factors such as the side of insertion, screw diameter, and skeletal type showed no significant effects[3].

In orthodontic miniscrews of 1.6 mm diameter, regardless of the insertion method, the insertion torque increased with length. For orthodontic miniscrews of 1.4 mm diameter, and here was no statistical difference in the maximum ITV required for the continuous rotation insertion and intermittent rotation insertion methods between inserting orthodontic miniscrews of similar dimensions [4].

Sarul et al. compared the long-term stability of 6mm and 8mm miniscrews in the mandible within a homogeneous group of patients. They found that the 8mm orthodontic miniscrews were significantly more stable than the 6mm ones. The length of the TAD may be one of the factors affecting the long-term success rate in the mandibles of 20- to 29-year-old women, with the 8mm orthodontic miniscrews showing significantly greater stability in this group[5].

In a retrospective study, A. Manni et al. found that success rates were higher in male patients (88.1%) compared to female patients (76.4%). They also observed that a diameter of 1.3 mm was superior to a 1.5 mm screw diameter in achieving primary stability. Additionally, the success rates were significantly higher for miniscrews placed in the maxilla (86.9%) compared to those in the mandible (76.1%)[6].

Mohammadi et al., in their retrospective study, concluded that patients under 16 years of age and insertion torques exceeding 10 Ncm were associated with an increased failure rate of orthodontic miniscrews[7].

The aim of this retrospective study is to assess the correlation between influencing factors such as patient age, gender, insertion side, and miniscrew length with the success and failure rates of orthodontic miniscrews.

Materials and Methods

Data from the medical records of 72 patients from private clinic, who underwent miniscrew placement between 2021 and 2023 were retrospectively reviewed. A total of 142 miniscrews were inserted.The data extracted from the medical records included the date of miniscrew placement, the date of miniscrew removal or failure, the length and diameter of the miniscrew, the placement side, the age and gender of the patient. All patients and their parents were provided with detailed information and the consent was obtained through the signing of an agreement form.

Miniscrews of three different lengths (6mm, 8mm, and 10mm) were inserted, all with a diameter of 1.65 mm (Tomas, Dentaurum, Germany). These miniscrews were placed using the self-drilling method by the same surgeon, without prior drilling. Preoperative mouth rinsing with a 0.1% chlorhexidine solution occurred two days before and on the day of insertion.

Local terminal anesthesia, using an adrenaline-free anesthetic, preceded the placement of miniscrews. Following the surgery, patients were provided with standard postoperative care instructions, including gentle brushing of the surgical site to maintain oral hygiene. Additionally, patients were prescribed a 0.2% chlorhexidine mouth rinse to be used twice daily for one week.

A miniscrew was considered successful if it did not fail or show signs of mobility over a period of six months from the day of insertion. All miniscrews were loaded three weeks after insertion [8,9].

The failure of a miniscrew implant is defined as either the dislodgement of the miniscrew implant before loading or when a miniscrew becomes excessively mobile, thereby impeding the achievement of orthodontic anchorage objectives.

Patients were categorized into three groups based on their age: Group 1 (8-19 years), Group 2 (20-39 years), and Group 3 (40-60 years).

This research study has been conducted in full accordance with the World Medical Association Declaration of Helsinki.

Statistical Analysis

We used Logistic Regression model to analyze the relationship between various factors and the success-failure rate and descriptive statistics to summarize our findings. To assess the relationship between the categorical influencing factors and the miniscrew success/failure rate, the chi-square test was used.To compare the mean levels of different variables, the t-test was used.

The analysis was performed using SPSS 16.0 software (version 16; SPSS, Chicago, IL, USA). The level of significance was set at P = 0.05

Results

Totally 142 miniscrews were inserted in 5 different sides: Buccal Upper left, Buccal Upper right, Buccal Lower left, Buccal Lower right , Anterior Palate. Overall success rate was 90.14 % (128 miniscrews) and overall failure rate was 9.86 % (14 miniscrews). Amount of placed miniscrews in different zones with related success rates are shown in Table 1.

Table1.Success Rates of Different Insertion Si

Insertion Side	Overall amount	Success	Failure	SD(success)	SD(Failure)	Chi-square (p-value)
Total Miniscrew	142	128 (90.14%)	14 (9.86%)	13.27 %	12.6 %	
Buccal Upper Right	29	28 (96.5%)	1 (3.5%)	5.9 %	5.68 %	p>0.05
Buccal Upper Left	23	21 (91.3%)	2 (8.7%)			
Buccal Lower Left	14	11 (78.6%)	3 (21.4%)			
Buccal Lower Right	11	10 (90%)	1 (9%)			
Anterior Palate	65	58 (89.3%)	7 (10.7%)			

The lowest success rate was observed on the buccal left side of the mandible at 78.6%, while the highest success rate was observed on the buccal right side of the maxilla. The success rate of miniscrews placed on the anterior palate was 89.3%. However, other placement sides exhibited significantly higher success rates ranging from 90% to 91.3%. Despite these differences, chi-square testing revealed no correlation between placement sides and miniscrew success/failure rates (p>0.05).

The success rates for miniscrews with lengths of 10 mm and 8 mm were almost equal at 91.8% and 88.88%, respectively, while miniscrews with a length of 6 mm showed no failures. Chi-square testing indicated no correlation between miniscrew length and the success/failure rate of miniscrews (p>0.05).

Additionally, the success rates of patients in Group 1 and Group 2 were similar, but patients in Group 3 exhibited a success rate almost 1.4 times lower than that of patients in Groups 1 and 2. Chi-square testing revealed a statistically significant correlation between patient age and the success/failure rate of miniscrews (p< 0.05). (Tab. 2)

Table 2 Success Rates of Different Miniscrew Lengths

Miniscrew Lenght	Overall amount	Success	Failure	SD(success)	SD(Failure)	Chi-square (p-value)
10 mm	49	45 (91.8%)	4 (8.2%)	0.27 (0.29%)	0.09 (0.9%)	p>0.05
8 mm	90	80 (88.88%)	10 (11.12%)	0.32 (0.36%)	0.1 (0.95%)	
6 mm	3	3 (100%)	0	0	0	

The success rate of miniscrews placed in male patients (96%) was higher than that of those placed in female patients (87.1%). Only two miniscrews failed in male patients, while twelve failed in female patients. However, chi-square testing revealed no correlation between the gender of patients and the success/failure rate of miniscrews (p > 0.05). (Tab. 3)

Table 3: Success Rate by Age group and Gender

Patients age	Overall amount	Success	Failure	SD(success)	SD(Failure)	Chi-square (p-value)
Group 1(8-19 years)	73	68 (93.1%)	5 (6.84%)	0.25 (0.28%)	0.25 (3.72%)	P<0.05
Group 2(20-39 years)	57	52 (91.2%)	5 (8.77%)	0.28 (0.3%)	0.28 (3.29%)	
Group 3(40-60 years)	12	8 (66.7%)	4 (33.3%)	0.47 (0.7%)	0.47 (1.4%)	
Gender						
Male	49	47 (96%)	2 (4%)	0.19 (19.69%)	0.2 (20.27%)	p>0.05
Female	93	81 (87.1%)	12 (12.9%)	0.32 (32.2%)	0.11 (11.04%)	

Discussion

The stability of miniscrews is crucial for reliable anchorage and predictable orthodontic treatment outcomes. Miniscrew failure can significantly impact the initial treatment plan. Numerous studies have investigated the success/failure rates of miniscrews, yielding varied results. In our retrospective study, the success rate was found to be 91.8%, which aligns closely with the findings of some of the aforementioned studies[2,3,10,11].

We observed a relatively high success rate for interradicular placements (90-96.5%), except in the lower left quadrant. This phenomenon might be connected to the fact that the surgeon was right-handed, making left-side placement less convenient.

In some cases, bicortical fixation was achieved in the upper jaw, which can significantly increase stability[12]. Additionally, nearly half of the interradicularly placed miniscrews were utilized as indirect anchorage.

Forty-five percent (65 pieces) of all miniscrews were placed in the anterior palate, and seven of them failed. All palatally placed miniscrews were inserted without predrilling and had a length of 8 mm. Interestingly, in one patient, miniscrews placed in the anterior palate failed three times, significantly impacting the statistics. The overall success rate was 89.3%, which differs from findings reported in several studies[10,13,14].

The correlation between patient age and miniscrew survival rate has been studied by different authors[6,10,14-17].

In this study, a significant portion of all miniscrews were placed in patients under 40 years of age (91.5%). Specifically, 73 miniscrews were placed in patients aged 8-20 years, with a success rate of 93.1%, while 57 miniscrews were placed in patients aged 20-40 years, achieving a success rate of 91.2%. The number of miniscrews placed in patients over 40 years of age was considerably less (only 12 miniscrews), with a success rate of 66.7%. Interestingly, all miniscrews placed in patients over 40 years were interradicular.

We found that the difference in success rates between male and female patients was not statistically significant. These results are similar to those reported in several other studies. However, there are also studies that have suggested a correlation between patient sex and miniscrew success rate [6,18-20].

In summary, our study indicates a relatively high success rate of orthodontic miniscrews. We observed the highest success rate in the upper right quadrant and the lowest rate in the lower left quadrant. Despite examining various factors such as insertion site, miniscrew length, patient age, and sex, we found a significant correlation only between success rate and patient age. Specifically, we noted a lower success rate in patients over 40 years of age compared to those under 40. It's important to note that our study did not consider factors such as malocclusion type, growth type, or anchorage design. These findings underscore the need for further research to better understand the factors influencing miniscrew success in orthodontic treatment.

Conclusion

Orthodontic miniscrews can serve as reliable anchorage for various types of tooth movement. This retrospective study revealed that miniscrew success rate is not significantly influenced by insertion side, miniscrew length, or gender, but rather by patient age. Interradicular placement of miniscrews exhibits a success rate comparable to that of miniscrews placed in the anterior palate.

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Conflicting interest

None

Ethical Approval

Institutional Human Ethical Committee Yerevan State Medical University and was conducted in accordance with the Declaration of the World Medical Association.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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