

# Success and Failure Rates of Orthodontic Mini-screws: A Systematic Review

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**Aim:** The purpose of the present study was to systematically review the literature on the success and failure of the miniscrews.

**Materials and Methods:** Titles and abstracts in Medline Databases (PubMed) were screened by 2 reviewers. First result contains 273 articles, after search filters they have reached to 9 articles. All articles were discussed by 2 reviewers and disagreements were solved.

**Results:** The total success rate were available in all 9 studies and ranged from 70.3% to 96%. The number of treated patients were ranged from 15 to 141 and also the number of miniscrews ranged from 44 to 260. The success and failure rates of miniscrews in these 9 studies had no significant correlation with gender. Statistic methods are different among these clinical trials.

**Conclusion:** It seems that weak consensus exist between bulk of data obtained from different clinical trials. Gender has been mentioned as a predisposing factor for success/failure rate and some article reported more success for male, some for female, and some no difference. Immediate loading has more success rate according to some investigations but many investigators suggest a healing period and delayed loading. Diameter and length of miniscrews and their dispersion factor is another source of inconsistency among authors. Diameters start from (in millimeter) 1.2, 1.3, 1.6-1.8 to 2 mm and length starts from (in millimeter) 5, 6,7,8 to 10 mm and different success rate is reported for these parameters. Even success/failure rate is described differently among clinicians and it start from stability during first one week, extends to six month and two year. In addition, some authors believe that because of the pool of subjects (large sample with important elements) in retrospective studies, appropriate statistics are “Kaplan-Meier survival curves” based on rigorous clinical success/failure criteria instead of success/failure rate.

**Key Words:** Miniscrews, Mini-screw, Miniscrew AND Success, Miniscrew AND failure, Orthodontic Anchorage procedure

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## Introduction

Anchorage is one of the major factors in Orthodontic treatment. A suitable anchorage device can aid the orthodontist to achieve treatment goal and have a desired tooth movement, and also decreased undesirable effects. Although, anchorage mostly can be obtained by extraoral or intermaxillary appliances; in some cases, because of minimum patients cooperation another type of devices may be used as anchorage. To eliminate patients cooperation, Temporary Anchorage Devices (TAD) were introduced (1). In recent years, miniscrews become well-known as an absolute anchorage device in orthodontics. Various tooth movements have become possible by inserting miniscrew, another advantage is the non-compliance nature of miniscrew, which needs less co-operation of patients. Studies investigated the effects of this type of anchorage device in orthodontic treatments, have shown many different results; therefore, in this review we are about to determine success rates and failure rates of miniscrew in clinical studies and to explore clinical feasibility of the mentioned anchorage device. Different intervening factors have been mentioned in the literature regarding the possible role of them in success and failure rate e.g. the distance between miniscrew or mini-implant and root surface, bone density, bone contact length, insertion angle, clinical experience of the clinician, gender and insertion site.(2-5)

## Material & Methods

An Electronic Medline search from year 2009 up to 2014 was conducted with search-term combinations as following: 'Miniscrews', 'Mini-screw', 'Miniscrew AND success', 'Miniscrew AND failure'. Inclusion criteria were defined to filter the search:

1. English Articles
2. Studies only on Human
3. Randomized Clinical Trials, Prospective and Retrospective cohort studies
5. No studies with fewer than 20 miniscrews
6. Patients examined in follow-up visits in studies
7. Reported details on miniscrew types used.

8. Additional data on factor related to failure and success rate of miniscrews

## Exclusion Criteria

Observations with less than 12 weeks period of study, non-clear loading time, and multiple publication of the same cohort study in different research journals at different time points were excluded from the review.

## Data Extraction

Information on the success and failure rates of orthodontic miniscrews was retrieved on the 273 studies included. Data extraction was limited to the last five years. Human studies and English language were also included in this category. From the 108 included studies, clinical trials and cohort studies were extracted. Disagreement regarding data extraction was resolved by consensus.

## Search Strategy and Selection of studies:

Figure.1 shows the search strategy used in this review to select articles by mentioned inclusion criteria. Titles and abstracts in Medline Databases (PubMed) were screened by 2 reviewers. First result contains 273 articles, after search filters they have reached to 9 articles. All articles were discussed by 2 reviewers and disagreements were solved.

## Results

The total success rate were available in all 9 studies and ranged from 70.3% to 96%. The number of treated patients were ranged from 15 to 141 and also the number of miniscrews ranged from 44 to 260.

The success and failure rates of miniscrews in these 9 studies had no significant correlation with gender. Although, in the study of Al Maaitah et al, the authors assessed bone density in female and male, which showed significant thicker cortical bone in male (6). This result might have an effect on the success rate of miniscrew between male and female, and influence on the placement site and mobility of miniscrews. Success rate of the miniscrews in the aforementioned study was 88.6% that agreed with rates reported in previous studies from 50% to 93.43%. (7) They concluded that miniscrews increased the alveolar bone density significantly after 3 months of insertion and were not

associated with detrimental effects on the adjacent gingival tissues.

In the study by Lee et al, the experiment was done on 36 female subjects, the author acclaimed that by choosing only female subjects, the variations in linear measurements will be minimized(8). Patients requiring maximum incisor retraction because of bidentoalveolar protrusion were divided into 2 groups, group A, miniscrew between the premolar and the molar, and group B, miniscrew between the premolars. Selection of the placement site appeared to be an important determinant for the resultant displacement pattern of the incisor segment. Discriminative intrusion or retraction might be obtained via strategic miniscrew positioning and success rate in this investigation was 94.4% which was higher than previous reports.(8)

Many studies have found no significant differences between success rate and age, but Kim et al, reported that younger patients less than 15 years of age had a higher failure rate than older patients. Logistic regression analysis showed that older patients had higher success rate, the author explained that it might be attributed to a difference in bone density, because calcification is completed in adults not in adolescents (9).

Miyazawa et al. have performed a study on 18 patients with 44 self-drilling miniscrew implant to be placed in interradicular bone using a surgical guide procedure. Authors concluded if orthodontic force could be applied to the screw until completion of orthodontic treatment, screw anchorage was recorded as successful. The total success rate of all miniscrews was 90.9 per cent (40/44).(10)

Two studies compared left side to the right side in miniscrew placement (11, 12). Lee et al showed that there is no significant difference in the success rate between implantation sides. Son et al, compared self-tapping and self-drilling methods in two different placement sides; the right side with either method had lower success rate than the left side but the results were not statistically significant. Lee et al. investigated the survival characteristics and risk factors of mini-implants with survival analyses. They concluded that decreasing pattern of the hazard function suggested gradual osseointegration of orthodontic mini-implants (C-implant). C-implant system needs a 2-stage surgery

procedure and a 4-week healing period. Age variable had a significant association with success rate and success rate was up to 93.8%. Survival analysis might be a better method of investigating implant failure, instead of reporting only the ratio of success and failures.(11)

Son et al. studied the influence of self-tapping and self-drilling placement techniques on the stability of miniscrews. The success rates (endurance for 6 month or more) of the miniscrews were approximately 96% with either placement technique. The success rates of the self-tapping and the self-drilling methods in the right side were 94.3% and 91.4%, respectively; the success rates in the left side were 97.1% and 100%, respectively. Both placement techniques showed high stability in the maxillary bone, although the self-drilling miniscrews with root contact had greater mobility. Special attention to root contact further improves the stability of the self-drilling miniscrews.(12)

From placement site perspective, two study compared its characteristics. (9, 13) Kim et al, used Midpalatal and parapalatal area as insertion site of miniscrew. Miniscrew were placed in Parapalatal area in adolescents subjects to prevent possible damage to the developing sutures. The miniscrews in the parapalatal area showed a significantly lower success rate (72.2%) than those inserted in midpalatal area (92.5%). In the study by Suzuki et al, the success rate of miniscrews was analyzed between mandible and maxilla. A significant lower success rate was observed in mandible with 5-mm length miniscrews. There was no difference between the miniscrew lengths in maxilla and there was no difference between the left and right side. Kim et al. concluded placement of the miniscrew in the midpalatal suture, patient's age (especially >15 years), and operator's skill were factors influencing the clinical success of orthodontic miniscrews in the palate. The overall success rates were 88.20% for the total number of patients and 90.80% for the total number of miniscrews.(9) Suzuki et al. concluded that the success rate of the miniscrews in the maxilla (93.4%) was higher than that in the mandible (70.3%). The optimum lengths of miniscrews of a diameter of 1.3 mm are 5 mm in the maxilla and 6 mm in the mandible. They should be placed at a distance from the root with insertion torque less than 10 Ncm for safe orthodontic anchorage without failure.(13)

Deguchi et al. concluded that ideal occlusion can be achieved in adults with severe open bite with both conventional edgewise and implant anchored orthodontic treatment. However, absolute intrusion of the molars and improvement in esthetics might be achieved more effectively by using miniscrews as an anchorage device.(14)

All the studies included data regarding screw length and diameter. The range of length were from 5 to 9 mm and diameter from 1.3 to 2 mm. Some articles only pooled a specific screw with length, while others explained all data in details. Kim et al found no significant difference between miniscrews of 1.5mm and 2.0mm in diameter; this might be because of alike bone quality and quantity in subjects which have masked the difference in diameters.

In another study by Suzuki et al, the experiment compared 3 different lengths of miniscrews to determine the success rate regarding length of miniscrews (13). Miniscrews, 5-mm long were used in this study which had not been used in previous studies (15-17). From the results of mentioned study, no significant differences in the success rates among the length were observed in maxilla; however, a significantly lower success rate was seen in 5-mm long miniscrew in mandible. It is known that success rate in mandible is lower than maxilla (15-17). The author also claimed that, 5-mm might be the minimum ideal length of miniscrews that can resist 150g of orthodontic force in the maxilla.

All studies concluded loading time, which was ranged from less than 6 months until 2 years, loading duration in most of the studies were until the completion of the orthodontic treatment. Three studies reported immediate loading for miniscrew (9, 12, 13). The others reported healing periods ranged from 2 weeks to 4 weeks. The amount of loading in these 9 articles ranged from 50g to 800g.

## Discussion

The aim of this review was to evaluate the success and failure rate of miniscrews in clinical studies on human since 2010. It is difficult to design a randomized clinical trial (RCT) to compare different types of miniscrews and the effect of various factors on success and failure

rate. Hence, RCT studies on miniscrews are rare. Compare with other skeletal anchorage devices such as mini implants and mini plates, miniscrews have the advantage of simple surgical procedure, and the procedure can perform by orthodontist. Screws with diameter of 1.2mm or greater were used as success rates above 70% (18). Length is also a major factor in success rate(17, 19, 20) ; however, increasing the length and diameter of miniscrew might damage adjacent tooth roots (21). Careful treatment planning, radiographic evaluation of the placement site, usage of surgical guide can minimize this risk (10, 22-24). Root contact or even root proximity is also a major risk in insertion of miniscrews (3, 25).

Miniscrews success rate is also higher in maxilla compared with mandible. Studies significantly reported this comparison (13, 16, 26, 27). A suggested reason for low success rate in mandible is narrow interradiacular space, especially in posterior region (13) , other authors claimed overheating of the bone during placement is the cause of failure in mandible. Care must be taken for initial drilling before inserting the miniscrew.

Placement site is also another issue considering miniscrews. Some areas are much preferred because of enough bone and distance from adjacent root or other tissues such as nerves and vessels. Orthodontist should be aware of the areas with thin cortical bone plates which increase the risk of miniscrew failure (28). Also, Interdental buccal cortical bone thickness varies in the jaws(29), clinician should know about the mean thickness of the bone in the placement area before inserting miniscrews. Most studies reviewed in this article, inserted miniscrews in interradiacular bone of maxilla between second premolar and first molar. "safe zones" for placing miniscrews in the maxilla is between canine and second molar on the palatal side, and between canine and first molar on the buccal side. In mandible, interradiacular space between canine and second molar is the "safe zone"(30).

## Conclusion

Miniscrew is an efficient armamentarium in orthodontic treatment and has a crucial role as an absolute anchorage in tooth movement to the predetermined position. All articles reviewed, shows efficient success rate for applying miniscrews as an anchorage device.

The maxilla was shown to be more suitable for miniscrew insertion, which means, palatal miniscrews are also a superior treatment option. Immediate loading can be done for miniscrews according to no additional stability for delayed loading miniscrews after healing period. It seems that weak consensus exist between bulk of data obtained from different clinical trials. Gender has been mentioned as a predisposing factor for success/failure rate and some article reported more success for male (2), some for female (3, 31), and some no difference(32). Immediate loading has more success rate according to some investigations (2, 32) but many investigators suggest a healing period and delayed loading.(33) Diameter and length of miniscrews and their dispersion factor is another source of inconsistency among authors. Diameters start from (in millimeter) 1.2 (32), 1.3 (13), 1.6-1.8 (32) to 2 mm and length starts from (in millimeter) 5 (13, 34), 6,7,8 (32) to 10 mm (32) and different success rate is reported for these parameters. Even success/failure rate is described differently among clinicians and it start from stability during first one week (4), extends to six month and two year.(35) In addition, some authors believe that because of the pool of subjects (large sample with important elements) in retrospective studies, appropriate statistics are “Kaplan-Meier survival curves” based on rigorous clinical success\failure criteria instead of success\failure rate.(36) History of miniscrew is controversial and authors believe that introducing the surgical screws as an absolute anchorage by first author has been an important initiation for manufacturing the orthodontic miniscrews. (37)

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