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Original Research Article

Comparative evaluation of accuracy and stability of Orthodontic temporary anchorage device with and without the use of Mini-implant placement guiding device (MIG-20) in adults- An in vivo study

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ABSTRACT

Introduction: Mini implants have been researched extensively in terms of their efficiency, material used, and methods of accurate placement. When properly used,they might be a substitute method of anchorage preparation as compared toconventional molar anchorage and might reach alike or even superior results in certaincases.
Aim: The present study aimed to evaluate and compare accuracy and stability of orthodontic temporary anchorage device with and without the use of Mini-implantplacement guiding device (MIG-20) in adults.
Materials and Methods: Each patient underwent implant placement using both methods to have a similar oral environment for groups. Each case was treated in a split-mouth pattern to eliminateselection bias (to have the same baseline characteristics for both groups). Sideselection for that particular method was undertaken by using computer-generatedrandomization. So in all 2 groups were categorized. Mini-implant inserted by theconventional method (Control Group). Group II: Mini- Implant inserted by using MIG-20. Mini-implants were placed on both sides of the maxillary jaw between the 1 st molarand 2 nd premolar with the self-drilling manual method. Evaluation of clinical pictures, pre and post RVG and stability/mobility were done for each sample in both groupsusing AutoCAD software 2013.
Results and Observations: Out of 21 cases in Control group, it was observed that100% of cases in Control group had a vertically deviated mini-implant, which was statistically significant as compared to Study group, where 28.57% (6) cases demonstrated vertical deviation and 71.43 % (15) cases, where no deviation of miniimplantwas seen in vertical dimension when observed clinically. (p=0.0001, S). In71.43 % of cases, no significant variation was observed clinically in Study Group inmesiodistal dimension. (p=0.0001, S).
Conclusion: The findings of the study substantiate the effectiveness of the 3-D Mini-Implant placement guide (MIG-20) when compared to the conventional method, inachieving a more accurate mesiodistal and vertical placement of mini implants.

1. Introduction

Anchorage is an important consideration in Orthodontics, particularly if force is applied entirely to the teeth as it indicates the resistance necessary to prevent tooth movement where it is not desired while permitting movement where it is desired. It is the factor in determining the type of appliance that must be used to produce the type of tooth movement desired.

Conservation of anchorage has been a perennial problem for traditional Orthodontists. Intra-oral anchorage preparation methods using the tooth as anchorage cannot

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prevent undesired tooth movement of the anchor tooth.

With the advent of mini-implants after the pioneering studies, it is widely used by several Orthodontists as they offer "Absolute Anchorage". It was believed that, despite intense bone remodeling activity, the implants do not move considerably in response to the Orthodontic force and this was later proven wrong with the use of FEM study,[1] and other clinical research were done. The maximum deflection of 2.06 and 2.87 mm was found at the cortical bone interface under loading of 200 and 300 g, respectively.[2] In adults especially in whom the anchorage may be compromised by periodontal disease or loss of teeth, additional support may be desirable during Orthodontic intervention. With implants, we enter a new era of Orthodontic treatment. They may increase the treatment possibilities for patients and improve the functional results of the treatment.

It is suggested that root contact and marginal position might be a major risk factor for screw failure. If the distance between the screw and the marginal bone level is less than 1mm, it may lead to insufficient stability of the inserted mini screw.[3] Kuroda et al. suggested that there is a significant correlation between root proximity and the success rate of the mini-implant. They reported that when the body of the mini screw is overlaid on the lamina dura of the adjacent root of teeth, then the success rate drops to only 35%.[2]

Hence, the accuracy in mini-implant placement is of utmost importance as the deviated position of insertion of mini-implant leads to its placement closer to the roots which will not only compromise its stability and success but also may cause undesired consequences on the adjacent roots and bone. Moreover, the compromised stability of the mini screw will also compromise the retraction biomechanics.

Angulation of mini-implant with the long axis of the root has been suggested to be an important factor that contributes to the increased failure rate if it is not adequate. Meher (2012)[1] stated that the use of an angulated loading force to a perpendicularly placed mini-screw at 110-130°, rather than 70 to 90° minimizes stress and deflection, thereby increasing stability.

Kalra et al. evaluated Orthodontic mini-implant placement and suggested that a 2-dimensional radiograph, along with an implant guide is mandatory for routine Orthodontic implant placement.[4] Many authors have suggested the fabrication of a variety of mini-implant guides to determine the accurate position of the mini-implant placement. They can be categorized as 2-D and 3-D mini-implant guides.

2-D guides that are made of routine single-wire components are easy to fabricate, inexpensive, and easy to use, but possess the limitation of not assuring the contact of the mini-implant to the adjacent root. 3-D guides are the ones that are custom-made on the digital model of the patients. These may use stereo lithographic methods for fabrication, CAD-CAM-generated thermoplastic sheets, or auto-polymerizing resins.[5] For fabrication and evaluation of these 3-D guides, three-dimensional radiography like CBCT is a must. These Implant guides are to be custom-made for each insertion site, and for each patient and are highly expensive. They are not readily available to the clinician as and when required for immediate use and require assistance from biomechanical engineers or experts. It requires tremendous lab work and skills for fabrication.

Thus, there is a need to develop a cost-effective alternative that may be universally used in both maxillary and mandibular arch, either left and right side for all patients, and also should be able to provide 3-D control of mini-implant placement. This would ensure that the roots of the teeth proximal to the mini implant are safe.

One such attempt was made in our department. A mini-implant guide (MIG-20) was fabricated, which is made up of stainless steel and has to rotate and sliding wire components to adjust to the inclination of roots of adjacent teeth. The rotating components of this implant guide coordinate with the angulation of the proximal root surface, thus ensuring clinicians about the safe zone of interradicular bone for mini-implant placement. Sliding of these components makes it easy to orient the component universally at any implant placement site and in all patients. These components help clinicians to be aware of the proximal root surfaces adjacent to the interradicular area selected for mini-implant placement. Another peculiarity of MIG-20 is that it has horizontal wire components welded to a vertical wire which determines the height of the mini-implant placement and thus helps in the accurate vertical positioning of the mini-implant.

MIG-20 is probably inexpensive as compared to existing mini implant guides, autoclavable, and can be universally applied to all insertion sites and patients. It may provide three-dimensional control for the placement of the mini implant.

Therefore to evaluate how effective the 3D MIG-20 was, in the accurate placement of Orthodontic implants and whether that mini implant has improved stability when compared to the conventional method, a study was undertaken.

2. Aim

To evaluate and compare the accuracy and stability of Orthodontic temporary anchorage devices in adults using a Mini-implant placement guiding device (MIG-20), with those using the conventional technique.

3. Objectives

To evaluate and compare the accuracy of miniscrew in mesiodistal, vertical, and angular dimensions and stability (mobility) of inserted miniscrew using conventional technique and by Mini-implant placement guide (MIG-20).

4. Materials and Methods

The MIG 20 is placed in the patient's mouth as shown in Figure 2, clinical judgment is made and part a is approximated to the mesial root surface of the 1st molar, whereas part c approximates the distal surface of the 2nd premolar. Part b slides and is approximated between these 2 teeth. Now an RVG is taken and evaluated. If the clinical judgment is correct on the radiograph as seen in Figure 4 b, then the clinician can take this as guidance and mark the point for implant placement such that parts a and c will prevent the extension into root surfaces and part b will dictate the vertical height of the implant placement. Thus, a Mini implant can successfully be placed with the use of MIG 20.

4.1. Study design

An interventional study was conducted in the Department Of Orthodontics and Dentofacial Orthopaedics.

4.2. Sample selection

Sample size calculation was done using the formula for the difference between two proportions with a 95% confidence interval (Power of the test 80%). The estimated sample per group was 21. A simple random sampling method was used. A total of 21 patients, in the age group of 18-25 years, were selected from the patients coming to the Outpatient Department (OPD) of the Department. Patients who fit the inclusion criteria were included in the study after taking informed consent.

4.3. Inclusion criteria

1. Patients having malocclusion seek fixed orthodontic treatment.
2. Patients undergoing therapeutic extraction as a part of their treatment.
3. Cases with the requirement of critical anchorage.

4.4. Exclusion criteria

1. Patients with systemic issues and known bone disease were excluded from the study population.
2. Cases not indicated for mini-implant placement were excluded.
3. Patients having poor periodontal and gingival status.

The cases were randomly selected from the OPD of the department. After analyzing with the diagnostic aids those requiring premolar extraction and those indicated for Implant-supported anterior retraction were selected for the study and the following method for research was undertaken.

4.5. Methods

Each patient underwent implant placement using both methods to have a similar oral environment for groups. Each case was treated in a split-mouth pattern to eliminate selection bias (to have the same baseline characteristics for both groups). Side selection for that particular method was undertaken by using computer-generated randomization. So in all 2 groups were categorized

1. Group 1: Mini-implant inserted by the conventional method (Control Group)
2. Group 2: Mini-Implant inserted by using MIG-20 (Study Group)

Mini-implants were placed on both sides of the maxillary jaw between the 1^{st} molar and 2^{nd} premolar with the self-drilling manual method.

4.6. Mini- implant placement with conventional technique. (Control Group) (Figure 2)

1. Step 1: Pre-procedural Radiovisiography (RVG) was taken for the region between the roots of the 1^{st} molar and 2^{nd} premolar on one side without the use of any mini-implant guide.
2. Step 2: Mini screw was placed between the roots of 1^{st} molar and 2^{nd} premolar by self-drilling manual method, with the operator's best judgment.
3. Step 3: Post-procedural RVG and the clinical picture was taken.

4.7. Mini- Implant placement with the use of mini-implant guide-: Mig-20 (study group) (Figure 3)

1. Step 1: Pre-procedural Radiovisiography (RVG) was taken for the region between the roots of the 1^{st} molar and 2^{nd} premolar on one side with the use of a novel mini-implant guide. (MIG-20).
2. Step 2: An accurate insertion site was identified with the help of the innovative design of MIG-20.
3. Step 3: Mini screw was then placed between the roots of 1^{st} molar and 2^{nd} premolar by self-drilling manual method.
4. Step 4: Post-procedural RVG and clinical pictures were taken.

Loading of the mini implants was done immediately.

Evaluation of clinical pictures, pre and post-RVG, and stability/mobility were done for each sample in both groups using AutoCAD software 2013.

5. Results and Observations

All readings obtained were tabulated and subjected to statistical analysis. Analysis of the data was done by using descriptive and inferential statistics. The software used in the analysis was SPSS 24.0 and Graph Pad Prism 7.0 version and p<0.05 is considered as the level of significance. The statistical tests used for the analysis of the result were: Chi-square Test- To calculate proportion between groups and Students unpaired t-test- To calculate and compare mean between two groups.

5.1. Findings of evaluation of deviation in mesiodistal dimension

From the findings, it was observed that 100% of cases in the Control group demonstrated deviation in mesiodistal dimension clinically and radiographically which was statistically significant as compared to the Study Group (MIG-20), where only 28.57% (6) cases demonstrated deviation. In 71.43 % of cases, no significant variation was observed clinically in the Study Group. (p=0.0001, S). (Table 1)

When the mean deviation was statistically evaluated for significance using Student's unpaired t-test, it was found that in the Control group, the mean of 0.67mm ±0.1 of deviation in mesiodistal dimension was significantly higher than those observed in the Study group with a mean of 0.22 mm ±0.02. A significantly higher range of deviation was observed in the Control group as compared to the Study group. (p=0.0001, S), (Table 3)

When the direction of deviation was evaluated towards the molar and premolar tooth in both groups, we observed that 71.4% (15 cases) demonstrated radiological deviation towards the molar tooth and 28.5% (6 cases) deviated towards the premolar. This finding was statistically significant. (p=0.022, S) (Table 2)

5.2. Findings of evaluation of deviation in Vertical dimension

Out of 21 cases in the Control group, it was observed that 100% of cases in the Control group had a vertically deviated mini-implant, which was statistically significant as compared to the Study group, where 28.57% (6) cases demonstrated vertical deviation and 71.43 % (15) cases, where no deviation of mini-implant was seen in vertical dimension when observed clinically. (p=0.0001, S) Radiological findings correlate with clinical findings.Table 1,).

When the direction of deviation in the vertical dimension was evaluated, we observed 47.6% (10 cases) demonstrated clinical deviation towards the apical direction and 52.3% (11 cases) deviated towards the cervical margin of the alveolar bone. The comparison was statistically non-significant (p=0.53, NS), (Table 2,)

5.3. Findings of evaluation of deviation in angular dimension

The mean deviation in the angle of placement was found that in the Control group, the observed mean was 47.16 ° ±1.23 in angular dimension which was significantly higher than those observed in the Study group with a mean of 45.42 ° ±0.23. A significantly higher range of deviation was observed in the Control group as compared to the Control group. (p=0.004, S). (Table 3,)

It was observed that all deviated cases in both groups had increased angles of mini-implant placement. Highly significant values were obtained between the two groups. 52.38 % of cases in the control group and only 28.57 % of cases in the study group had greater angular deviation. (P=0.0009, S). (Table 2,)

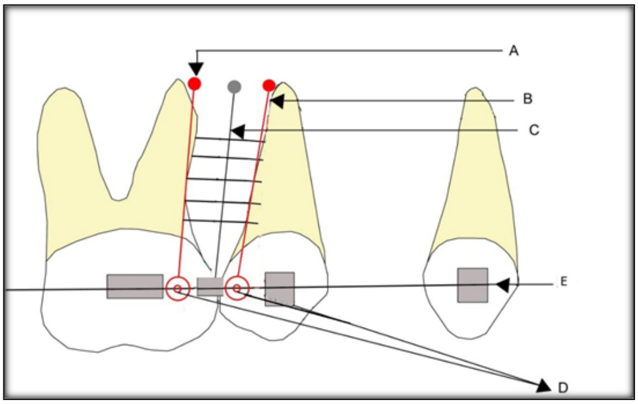


Figure 1: Characteristics of the Mini-implant guide (MIG-20)

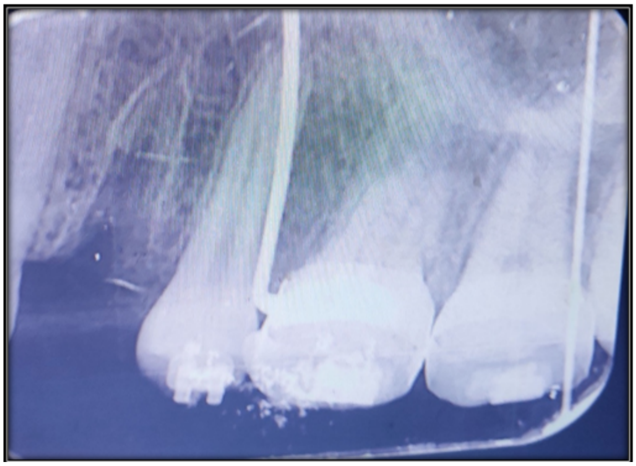


Figure 2: Pre-procedural RVG for the region between the roots of 1^{st} molar and 2^{nd} premolar on one side without the use of any mini-implant guide

Table 1: Comparison of clinical and radiological deviation in mesio-distal and angular dimension in both groups. (C- Clinical, R-Radiological)

Variables	Control Group		Study Group		χ2-value
	Deviated	**Not deviated**	**Deviated**	**Not deviated**	
C-Mesio-distal	21(100%)	0(0%)	6(28.57%)	15(71.43%)	p=0.0001,S
R-Mesio-distal	21(100%)	0(0%)	6(28.57%)	15(71.43%)	p=0.0001,S
C-Vertical	21(100%)	0(0%)	6(28.57%)	15(71.43%)	p=0.0001,S
R-Vertical	21(100%)	0(0%)	8(38.10%)	13(61.90%)	p=0.0001,S
Angular	11(52.38)	10(47.62%)	6(25.87%)	15(71.43%)	p=0.11,NS

Table 2: Comparison of clinical and radiological deviation towards molar and premolar tooth in mesiodistal dimension, apical and cervical margin in vertical dimension and towards lesser and greater angle in angular dimension in both groups. (C- Clinical, R-Radiological)

Variables	Control Group		Study Group		χ2-value
	Molar	**Premolar**	**Molar**	**Premolar**	
C-Mesio-distal	15(71.43%)	6(28.57%)	1(4.76%)	5(23.81%)	p=0.016,S
R-Mesio-distal	15(71.43%)	6(28.57%)	2(9.52%)	4(19.05%)	p=0.022, S
	Apical	**Cervical**	**Apical**	**Cervical**	
C-Vertical	10(47.62%)	11(52.38%)	2(9.52%)	4(19.05%)	p=0.53,NS
R-Vertical	8(38.10%)	13(61.90%)	3(14.29%)	5(23.81%)	p=0.97,NS
	Lesser than 45°	**Greater than 45°**	**Lesser than 45°**	**Greater than45°**	
Angular	0(0%)	11(52.38%)	0(0%)	6(28.57%)	P=0.0009, S

Table 3: Comparison of mean clinical and radiological deviation in mesiodistal and vertical dimension in both groups (C- Clinical, R-Radiological)

Variables	Control Group				Study Group				t-value
	N	**Mean**	**Std. Deviation**	**Std. Error Mean**	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	
C-Mesio-distal	21	0.67 mm	0.10 mm	0.02 mm	6	0.22 mm	0.02 mm	0.009 mm	p=0.0001,S
R-Mesio-distal	21	0.71mm	0.11mm	0.02mm	6	0.22mm	0.03mm	0.01mm	p=0.0001,S
C-Vertical	21	1.02mm	0.23mm	0.05mm	6	0.23mm	0.04mm	0.01mm	p=0.0001,S
R-Vertical	21	1.10 mm	0.30 mm	0.06mm	8	0.21 mm	0.02 mm	0.007mm	p=0.0001,S

Table 4: Comparison of clinical deviation in angular dimension, stability and mean mobility in both groups.

Variables	Control Group				Study Group				t-value
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean	
Angular	11	47.16 °	1.23 °	0.37	6	45.42 °	0.23 °	0.09	p=0.004,S
Mobility	3	52 ISQ	1 ISQ	0.57	21	69.14 ISQ	3.11 ISQ	0.68	p=0.0001,S
	Stable		Unstable		Stable		Unstable		
Stability	21	1.10 mm	0.30 mm	0.06mm	8	0.21 mm	0.02 mm	0.007mm	p=0.0001,S

5.4. Findings of evaluation of the stability of the mini implant

When the stability of the mini-implant placed using the conventional technique (Control group) was evaluated, 18 cases (85.71%) demonstrated unstable insertion as their value obtained using Osstell was less than 50 ISQ, and 3 cases (14.29%) demonstrated stability with ISQ value greater than 50 ISQ. Whereas in the Study group, all 21 cases (100%) showed ISQ values above 50 ISQ and hence were considered stable. (p=0.0001, S), (Table 4)

When the mean mobility was statistically evaluated for significance using the student's unpaired t-test, it was found that the mean ISQ value on measuring with Ostell for the Control group was 52 ISQ ± 1 and that for the Study Group was 69.14 ISQ ± 3.1. Thus results suggest that the mean ISQ value for the Study group is higher than the Control group. This finding was statistically significant. (p=0.0001, S). (Table 4, Graph 4)

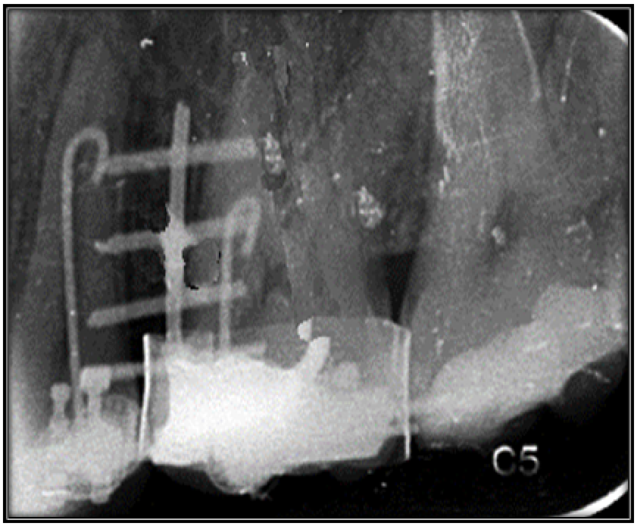
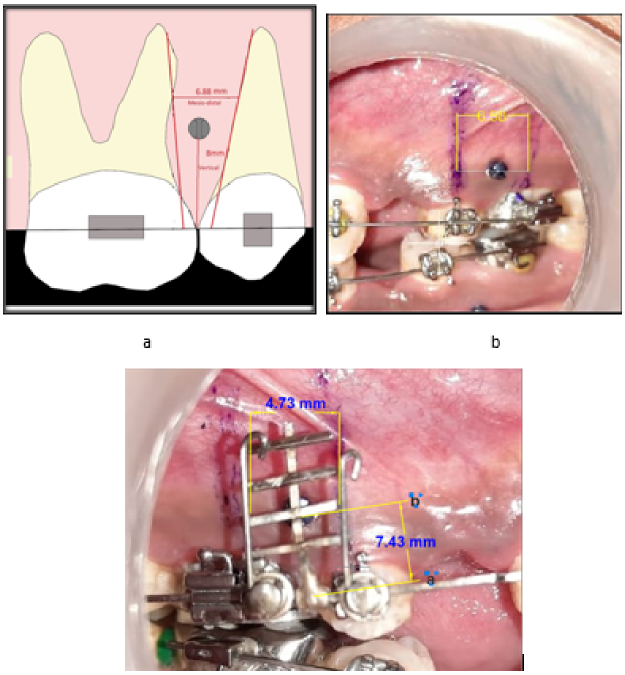


Figure 3: Identification of accurate insertion site using MIG-20 for mini implant placement



a b

c

Figure 4: **(a):**Schematic representation of Clinical evaluation of accuracy of miniscrew in mesio distal and vertical dimension in software **(b):** Clinical evaluation of accuracy of miniscrew placed by conventional technique in mesio distal and vertical dimension in software. **C:** Clinical evaluation of accuracy of miniscrew placed using MIG-20 in mesio distal and vertical dimension in software.

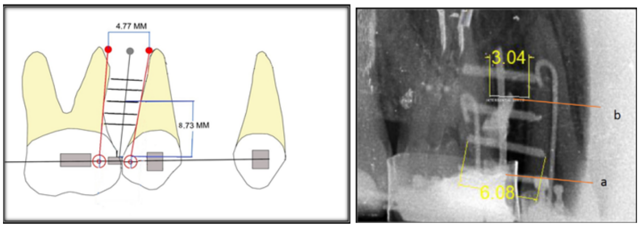


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Figure 5: **(a):**Schematic diagram of radiographical evaluation of accuracy of miniscrew in mesio distal and vertical dimension **(b):** Radiological evaluation of accuracy of miniscrew in mesio distal and vertical dimension

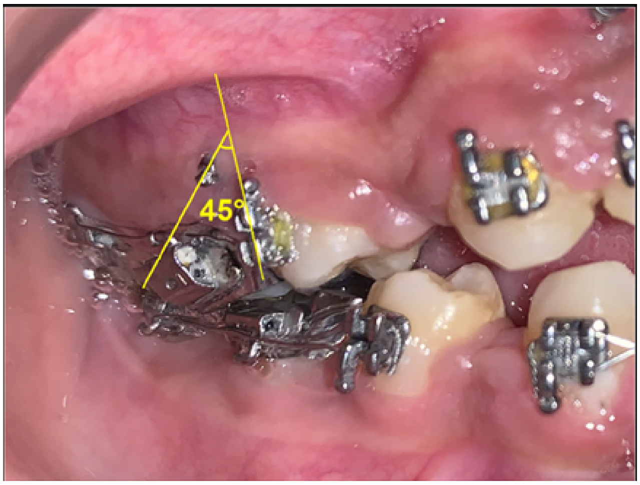


Figure 6: Evaluation of angulation of inserted mini screw to the long axis of the 2^{nd} premolar root.

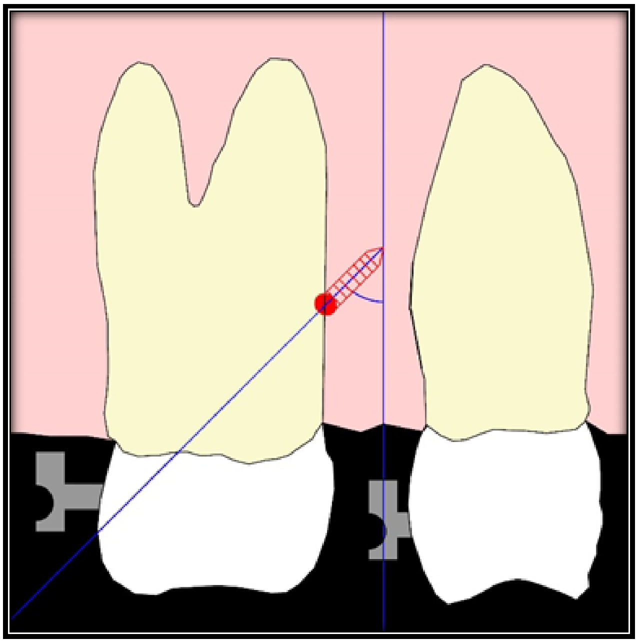
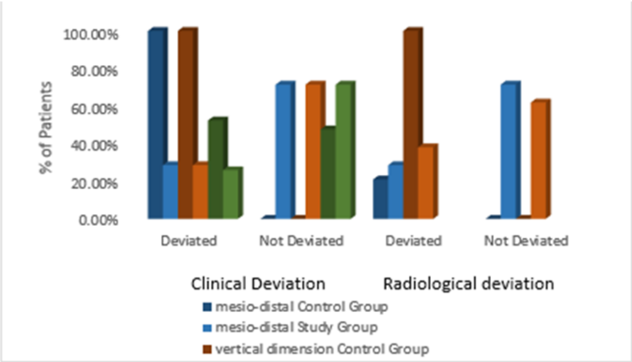
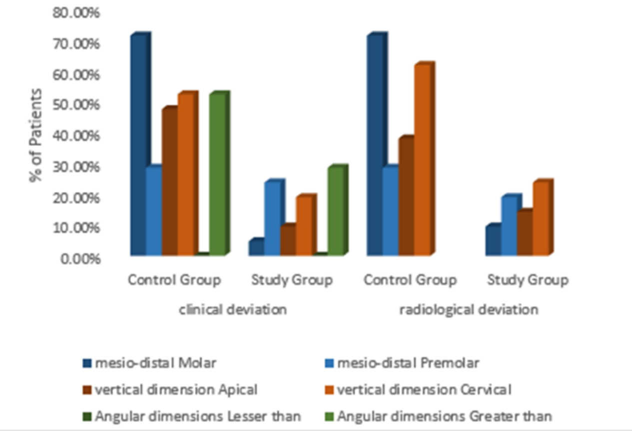


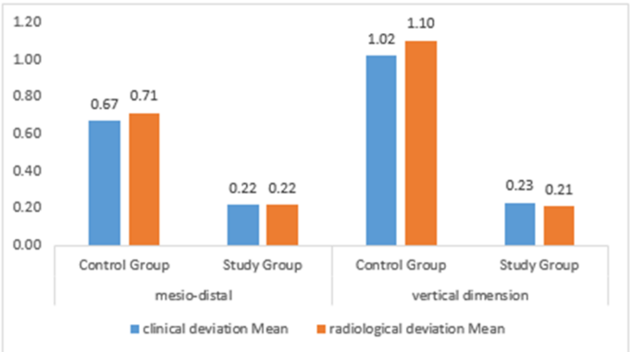
Figure 7: Schematic representation of evaluation of angulation of inserted mini screw to the long axis of the 2^{nd} premolar root



Graph 1: Comparison of clinical and radiological deviation in mesio-distal dimension in both groups.

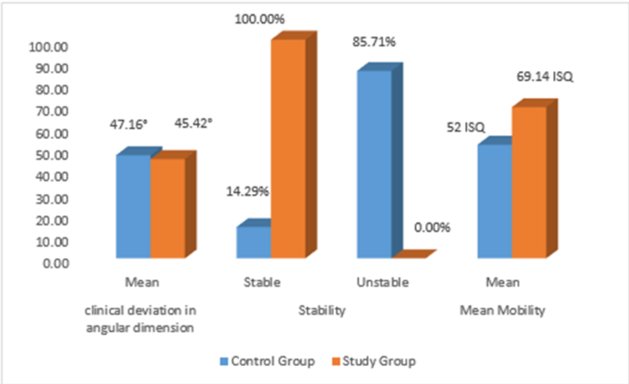


Graph 2: Comparison of clinical and radiological deviation towards molar and premolar tooth inmesiodistal dimension, apical and cervical margin in vertical dimension and towards lesser and greater angle in angular dimension in both groups



Graph 3: Comparison of mean clinical and radiological deviation in mesiodistal and vertical dimension in both groups

Figure 8: Evaluation of mobility of miniscrew implant using Osstell Device



Graph 4: Comparison of clinical deviation in angular dimension, stability and mean mobility in both groups.

6. Discussion

Anchorage preparation and preservation is essential to the branch of Orthodontics and Dentofacial Orthopedics. Mini implants have been researched extensively in terms of their efficiency, material used, and methods of accurate placement. When properly used, they might be a substitute method of anchorage preparation as compared to conventional molar anchorage[6] and might reach alike or even superior results in certain cases[7,8] According to Park HS et al., factors that compromise the success rate of mini-implants include host factors and mini-implant insertion technique.[8] The study by Janson et al.[9] demonstrated that the mobility of miniscrews and their success rate is affected by the distance of the miniscrew to the dental root at the insertion site.

Thus Accuracy of mini screw placement affects the stability of the mini screw. Complications arising due to mini screw failure could affect the adjacent root structure of teeth or can compromise the stability of the mini-implant, making it inefficient for force application during orthodontic treatment.[10]

Kravitz ND et al. suggest that the placement of a mini-implant in between the roots of the tooth necessitates Inter radicular placement requires appropriate radiographic evaluation, including a surgical guide with panoramic and periapical radiographs. This assists a clinician in deciding the innocuous location for mini-implant insertion.[11]

A 2-D mini implant guide developed and fabricated by Felicita AS consists of a single stainless steel wire part that is bent to form a 'U' with a 20° angulation.[12] This guide does not provide any specific information regarding the orientation and extent of the root surface of adjacent teeth, to prevent proximity to the root. It provides only mesiodistal centering but does not provide information regarding whether the implant placed is close to the root or not. Also, no arrangement was made to evaluate bone width at varying heights.

The 2-D stent described by Kravitz ND et al. consists of an anterior simplified stent that does not take into consideration the angulation of mini-implant placement.[13] Also, as the wire is placed flush with the bracket slot, it gives a wide area for mini-implant placement and hence a greater risk of root contact. Also, this guide fails to provide more accuracy in vertical dimensions for mini-implant placement.

Suzuki EY et al. gave a 2-D mini-implant guide that had a movable component along the orthodontic wire, thus it demonstrated the mesiodistal accuracy in the mini-implant placement.[14] It also consists of an angulated hole that ensures the mini-implant placement at an angle of 30°-40°. Thus a single implant guide cannot adequately assess the accurate placement of mini-implant in the vertical dimension. It does not inform about the height at which the maximum width of cortical bone thickness is present.

The limitations of the existing 2-D mini implant guide are that it does not ensure the proximity of adjacent root surfaces during the insertion of the mini implant. They may provide the point at which the widest mesiodistal dimension is present inter-radicular, but they do not give any idea whether the clinician is approaching closer to the proximal surface of the root during mini-implant placement. Angulation of the roots of the adjacent teeth may vary from case to case and these guides do not provide any adjustment to align the stent to the varying root angulations.

The 3-D stent described by Yu JJ et al requires the use of CBCT.[15] The insertion point position for proper orthodontic mini-implant implantation was identified using image slices from cone-beam computed tomography data, hence are very expensive. It also carries a risk of unnecessary radiation exposure.

The stent described by Kim SH et al was a stereolithographic 3-D surgical guide. It is fabricated using rapid prototyping.[16] Hence it is expensive and difficult to fabricate routinely.

Therefore to overcome the limitations of existing 3D guides and make it feasible for the common strata, an indigenous Implant placement guide (MIG-20) was developed in our Department.

The mean distance between the root and mini-implant in the Control group was found to be 2.17 mm and that in the Control group I was 2.7 mm. Any deviation either towards the distal or mesial side was evaluated and its mean was tabulated and analyzed. From the findings, it became evident that in the Control group, all cases (100%) demonstrated a deviation in the mesiodistal dimension i.e. the implant placement was not centered, in the widest inter-radicular area but was placed more off-centric. They were placed closer to the premolar root in 28.57% of cases and toward the molar root in 71.43% of cases. In the Study group, only 28.57% of cases demonstrated deviation beyond the expected limits.

If the tooth moves or the root of the adjacent tooth becomes angulated, this makes the implant migrate closer to the proximity of the root and may have to be reinserted during the treatment. Therefore in the Study group, the accuracy of placement of the implant in a more centered position was achieved which when compared to the Control group, failed to achieve accuracy in the mesiodistal dimension. Also in the Control group, the implants were placed closer to molar roots.

According to Kalra S, evaluation of the centricity of a mini implant is important, as, during orthodontic retraction, there is a tendency of mesial migration of 1^{st} molar. If the mini implant is placed more towards 1^{st} molar roots, then it may come close to the molar root during retraction mechanics. This may lead to failure of the mini implant or resorption of the root of the 1^{st} molar. On the other hand, if the implant is placed more towards the premolar root, it may not affect the stability of the mini screw, unless the distal movement of the 2^{nd} premolar root is desired.[4]

As stated by Sawada K et al, there should be a distance of at least 2.5 mm between the mini screw and the root of the teeth to assure avoidance of proximity of the mini-implant to the adjacent root.[17]

From the findings, it became evident that in the Control group, all cases (100%) demonstrated a deviation in the vertical dimension i.e. the implant placement was not at the optimum vertical height. In the Study Group, only 28.57% of cases demonstrated deviation beyond the expected limits and the remaining 71.43% exhibited a more accurate implant placement. (Table 1, Graph 2)

Along with the accurate mesiodistal placement of the mini screw, it is important to assess the vertical position of the mini implant. Vibhute PJ et al, measured the thickness of cortical bone using computed tomography and found out that the cortical bone thickness is increased at the sinus floor level and above it than below the sinus floor.[18] The safer zone for placement of the implant concerning maxillary sinus level varies in different growth patterns, as was the finding of Vibhute PJ et al.

Various authors like Pickard MB et al.[19] and Araghbidikashani M et al.[20] stated that the ideal angulation of the mini implant in the maxillary arch between the 1^{st} molar and 2^{nd}premolar should be 45°. Hence in our study 45° was considered as the ideal angulation for mini-implant insertion. From the findings, it became evident that in the Control group, 11 cases (52.38%) demonstrated a deviation in the angular dimension i.e. the implant placement deviated, from the ideal placement angle of 45°. All 11 cases, had deviation towards the greater side i.e. all deviated mini-implants were placed at an angle of more than 45°. In the Study Group, only 25.87% of cases demonstrated deviation from the ideal angulation of implant placement and the remaining 71.43% exhibited a more accurate implant placement. (Table 1, Graph 1)

Angulation of mini-implants with the long axis of the root has been extensively studied in the literature. Meher AH et al stated that the use of an angulated loading force to a perpendicularly placed mini-screw at 110-130°, rather than 70-90° minimizes stress and deflection, thereby increasing stability. The angle of mini-screw insertion should be less than 90° because an angulated rather than perpendicular insertion is thought to increase the relative thickness of the cortical bone.[1] Achieving a perpendicular or 90° placement may insert the mini implant in areas closer to roots.

Mobility of the mini-implant was checked immediately after insertion (primary stability) with the Osstell device, post-insertion. Mini implants with ISQ values less than 50 were marked as unstable. In the Control group, out of 21 mini implants, 18(85.71%) were found to be unstable. The Study Group showed that all 21 mini-implants were stable post-insertion. This suggests that the mini implants were more stable in the Study Group as compared to the Control group and the difference is highly significant. (Table 4, Graph 4)

The success of a mini implant depends on its primary stability and long-term stability. Primary stability is the firmness of the mini implant soon after its insertion at the determined site. Long-term stability is the steadiness of the mini implant during the application of retraction biomechanics. Poor primary stability compromises long-term stability. Loosening of the mini screw during the retraction phase may altogether lead to failure of Orthodontic treatment.

There are multiple 3-dimensional guides for mini-implant insertion in the literature. Most of them have only reported cases and some of them have evaluated accuracy with those implant guides.

Yu JJ et al.,[15] studied the accuracy of a surgical stent for mini-implant placement on CBCT. The surgical stent was fabricated using an expensive setup of custom-designed surveyors. The limitations of their method were that the mesiodistal and vertical dimension of placement was not considered. CBCT images were necessary for the evaluation, causing undue radiation exposure and making it more expensive for regular practice.

The accuracy of mini-implant placement with a 3-D radiographic surgical guide was studied by Janson G. et al. One limitation of this implant guide was its complex design of fabrication. Also, this mini implant guide cannot provide predictions in the vertical dimension. It consists of a hole in the guide design to suffice for mesiodistal accuracy, whereas MIG-20 has rotating features in its wire parts that align the implant guide to the angulation of the tooth root.

A comparison of the accuracy of mini-implant placement using a 2-D guide using RVG and a CBCT prediction was studied by Kalra S et al. The limitations of their 2-D implant guide were insufficient and nonadjustable implant guide in vertical dimension for implant insertion which compromises the stability.[4]

In contrast, the MIG-20 used in the Study Group of our study uses RVG as a diagnostic aid which causes lesser radiation exposure than the one used by Kim HS et al.

Multiple implant placement guides should be mandatorily used during Orthodontic implant placement to achieve accuracy in placement as well as ensure that it causes the minimum undesired outcome. Results suggested that accurate mini-implant placement can be done using MIG-20, which is a simple, inexpensive, and autoclavable alternative as compared to the above-mentioned.

MIG-20 is one such guide that can be safely used for a more accurate mesiodistal and vertical placement and it also ensures accuracy in angulation as well as primary stability of mini implants. These factors are the primary objectives necessary for increasing the success of orthodontic implants.

7. Conclusion

The findings of the study substantiate the effectiveness of the 3-D Mini-Implant placement guide (MIG-20) when compared to the conventional method, in achieving a more accurate mesiodistal and vertical placement of mini implants.

It was also able to achieve more accurate angulation and primary stability of the mini-implant which is necessary for preventing mini-implant failure.

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None.

9. Conflict of Interest

None.

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