Wu J, Huang J, Zhao S, et al. Radiographic and surgical template for placement of orthodontic microimplants in interradicular areas: A technical note. *Int J Oral Maxillofac Implants 2006; 21: 629-34*.

Purpose: To evaulate the clinical accuracy of this newly developed technique.

Materials and Methods: 41 patients participated in this study. Microimplants were planned to provide absolute anchorage for retracting the anterior teeth.

<u>New technique</u>: A flat bite block 5mm thick is fabricated using acrylic resin on the teeth adjacent to the planned implant placement sites. The flat surface of the bite block is parallel to the occlusal place. Three 0.018-inch wires are placed in the resin block. A simple film holder can align the x-ray source, teeth, and film in a straight line and guide the central x-ray perpendicular to the radiographic film. After taking x-ray images, the film is clipped along the edge of the roots of interest and trimmed to make it fit the movable soft tissues near the site of placement.



Criteria: (1) Reinsertion of the drill or microimplant.

(2) Possible contact between the roots and the implant observed in the CT scans.

Results: The outcome of microimplants placed with the 2 techniques

	Number	of	implants	that	Number	of	implants	that	
	failed		•		succeede	ed	•		
Test technique	2				56				<i>P</i> < 0.05
Control technique	12				46				

Conclusions: The newly developed technique makes the possibility of root contacts reduced.

Rose TP, Jivraj S. and Chee W. The role of orthodontics in implant dentistry. British Dental Journal 2006; 201:753-64. (20refs.)

Purpose: To discuss the role of orthodontic treatment with implant and to present multidisciplinary case.

Materials and Methods Authors' opinion and one multidisciplinary case presentation.

Findings:

1: Orthodontics to develop the peri-implant site: Orthodontic extrusion allows the restorative dentist to create a more harmonious gingival level and aesthetically provide the patient with a restoration that mimics the contra-lateral tooth. Extrusion is performed at a rate of 1mm/week and a stabilisation periodo of on month for each millimeter extruded. Extrusion is the most predictable method of vertical bone development.

2: Orthodontics to create space for implant restorations: If the orthodontist has created 5.5mm of space and the platform of the implant is 4mm wide, then 0.75mm of space will remain between the implant and the adjacent central incisor and canine teeth. There should be 1mm of space between the implant and adjacent teeth. This space allows adequate healing and the development of the papilla.

3: Implant for orthodontic anchorage: The implants provide the qualities of an ideal orthodontic anchor: 1) patient compliance unnecessary; 2) absolute anchorage as there is no periodontal ligament; 3) easily used under a variety of treatment modalities; 4) easily placed; and 5) removable, if necessary.

Type of implant anchors:

Definitive implants: Once the implants are placed, orthodontic therapy proceeds based on the position of the integrated implants and any revisions to the treatment plan man not be possible. Disadvantages of root formed implants include: 1) cost, 2) Loading must be delayed for healing and osseointegration, 3) Placement limited to edentulous and retromolar areas, 4) Non restorable implants must be surgically removed after orthodontic use, and 5) Use in a growing patient may result in submergence of the implant.

Provisional implants: Immediate provisional implants are usually fabricated of a titanium alloy, and differ from definitive implant in two say; 1) osseointegration is not expected, and 2) they are susceptible to fatigue fracture and mobility with long-term use. Therefore, replacement during orthodontic treatment should be expected.

An ortho implant: Straumann's Ortho System

Mini-implant: It is basically a bone screw similar to the type used to fix bone plates for plastic reconstruction. It requires a two stage surgical procedure with an unloaded period for healing.

Mini-plate: It is a skeletal anchorage system employing titanium mini-plates temporarily implanted in the maxilla or mandible with bone screws as an immobile intra-oral anchorage source. It is particularly used for intrusion of molars to correct the skeletal open bite.

Conclusions: Osseointegrated implants for orthodontic anchorage can produce superior preprosthetic tooth movements for partially edentulous patients. An interdisciplinary and three dimensional planning of the implant location site is necessary in order not to compromise orthodontic movement or subsequent prosthetic treatment.

Kokich VG. Managing complex orthodontic problems: The use of implants for anchorage. Semin Orthod 1996;2:1-8.

Purpose: to document the use of implants to accomplish tooth movement.

Materials and Methods: Presentation of three case reports

Findings and Conclusion: The author described in his article three case reports where implants were used as anchorage and later abutments. He emphasizes on the importance of interdisciplinary treatment with good communication between all members of the team. Input from the restorative dentist, periodontist, oral and maxillofacial surgeon, and orthodontist will help to formulate the proper objectives, treatment sequence, and assure the quality of the final result. By carefully determining the proper position of the implant before orthodontic therapy, it may be used as an anchor for tooth movement, and also as an abutment for fixed restoration following the completion of orthodontic therapy. The author also emphazised on the importance of construction of a pretreatment diagnostic wax up. Another crucial step in the process is to determine the appropriate time for placing the implant. In most situations, the implant is placed before the orthodontic treatment begins. However, occasionally the implants will be placed during the orthodontic treatment. These are special situations, when tooth movement on either side of the implant may be unpredictable. Another issue related to timing is the age of the patient. If the patient is growing, a significant vertical discrepancy could occur between implants and natural teeth.

When implants are used as anchors for orthodontic movement, sufficient time must elapse between placement of the implant and application of the orthodontic force.

Hong RK, Heo JM, Ha, YK. Lever-arm and Mini-implant System for Anterior Torque Control during Retraction in Lingual Orthodontic Treatment. Angle Orthod 2004; 75:129-41. (26 refs.)

Purpose: The purpose of this study is to describe the lever-arm and mini-implant system as absolute anchorage for controlled retraction of the anterior teeth in lingual orthodontic treatment and to demonstrate the effectiveness of this system using clinical examples.

Materials and Methods: Literature review and case presentations.

Findings: Correct positioning of the maxillary and mandibular incisors is essential for function, stability, and esthetics. Retraction of the incisors is a critical stage in orthodontic treatment. The resultant movement of the incisors depends on the tissue retraction produced by the applied biomechanical force systems. Anterior torque control during retraction is difficult to achieve with lingual orthodontic treatment. Anterior torque control is achieved either by directly applying a moment and force to a lingual bracket or by using lever-arm mechanics to obtain the desired line of action of the force with respect to the center of resistance. In the lever arm-system, the desired tooth movement is attained by adjusting the length of the lever-arm and the point of force application. With labial appliances the existing oral anatomy may prevent ideal placement of the lever-arm system, but with lingual appliances, the lever-arm system can always be ideally located because of the width and depth of the palate. Therefore, lingual lever-arm mechanics can be effective in achieving any desired tooth movement.

Biomechanics: To design the optimal lever-arm and mini-implant system for obtaining the desired force system during retraction, the point of force application, and the line of action of the retraction force are planned using lateral cephalograms. By adjusting the length of the lever-arm and the position of the mini-implant, the desired line of action of the retraction force with respect to the center of resistance and the anterior segment is established. Mini-implants can control the point of force application in the posterior area and produce en masse retraction with no anchorage loss. When the length of the lever-arm is adjusted to the position of the mini-implant, the desired line of action of the mini-implant, the selected.

Determination of the length of the lever-arm and the position of the mini-implant: The center of resistance of the unit to be moved is the basic point for the arrangement of a force system. Vanden Bulcke et al have concluded that the instanteous center of resistance for the 6 anterior teeth was located at 7.0 mm apical to the interproximal bone level between the central incisiors (measured perpendicular to the occlusal plane). Using this defined location, the length of the lever-arm and the position of the mini-implant are determined on the lateral cephalogram before retraction. A lever-arm, made of 0.9 mm stainless steel wire, is soldered onto the mushroom archwire between the lateral incisors and canines and the fitting lever-arm length is determined. The proper insertion of the mini-implant are inserted under local anesthesia directly through the mucosa without any flap dissection. The fitting implant length is determined by assessing the thickness of the palatal soft tissue and the available bone quantity at the desired implantation site. The mini-implant system is completed.

Two protrusion cases are shown. In case 1, screw-type implants with a diameter of 2 mm and a length of 13 mm in the right side and 2x11 in the left side were used in the apical region of the posterior teeth. In case 2, screw-type implants 2x8 mm were used in the posterior area of the mid-palatal region.

Conclusion: Controlled retraction of the anterior teeth was achieved with no loss of anchorage. The mini-implant, in conjunction with the lever-arm, is useful not only for absolute anchorage but also for anterior torque control during retraction in lingual orthodontic treatment.

Papadopoulos MA, Tarawneh F. The use of miniscrew implants for temporary skeletal anchorage in orthodontics: A comprehensive review. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006. (82 refs.)

Purpose: To present and discuss the development, clinical use, benefits, and drawbacks of the miniscrew implants used to obtain a temporary but absolute skeletal anchorage for orthodontic applications.

Materials and Methods: Literature review

Findings and Conclusions:

1. Classification:

- (1) According to the shape and size:
- 1) Conical (miniscrew implants, palatal implants, prosthodontic implants)
- 2) Miniplate implants
- 3) Disc implants
- (2) According to the implant bone contact:
- 1) Osseointegrated
- 2) Non-osseointegrated
- (3) According to the application:
- 1) Used only for orthodontic purposes
- 2) Used for prosthodontic and orthodontic purposes

2. Types and properties:

(1) Biocompatibility: With the exception of the Orthodontic Mini Implant (stainless steel), all other systems are made of medical type IV or type V titanium alloy.

(2) Osseointegration: Most of screws are manufactured with a smooth surface, thereby minimizing osseointegration.

(3) Types of anchorage: When used for indirect anchorage, implants are connected through basis or wires to the reactive unit, whereas used for direct anchorage, they directly receive the reactive forces by acting as an anchor unit.

(4) Head design: buttonlike design with a spherelike shape or a hexagonal shape/ a design with a hole through the head or the neck/ bracketlike design/ hook design

(5) Thread design: The thread body can be either conical or parallel tapering only at the end. Most miniscrew implants have a thread diameter ranging from 1.2 to 2.0mm and a length from 4.0 to 12.0mm.

3. Clinical applications:

Clinical applications include correction of deep overbites, closure of extraction spaces, correction of a canted occlusal plane, alignment of dental midlines, extrusion of impacted canines, extrusion and uprighting of impacted molars, molar intrusion of mandibular teeth, en-masse retraction of anterior teeth, molar mesialization, upper third molar alignment, intermaxillary anchorage for the correction of sagittal discrepancies, and correction of vertical skeletal discrepancies.

4. Clinical procedures for implant insertion and removal:

(1) Possible sites for placement: In the maxilla, the area below the nasal spine, the palate, the infrazygomatic crest, the maxillary tuberosity, and the alveolar crest are possible sites. In the mandible, the symphysis or parasymphysis, the alveolar process, and the retromolar area are possible sites. In the maxilla, the safest insertion sites are located in the anterior and apical portion. In the mandible, the safest sites are between the first and second molars and between the first and second premolars. In the palate, there is sufficient bony support for implants ranging from 4 to 6mm in the midpalate. An alternative palatal site is located 6 to 9mm posterior to the incisive foramen and 3 to 6mm paramedian.

1) Localization of the point insertion:

2) Direction of implant insertion: Melsen recommends the placement of miniscrew implants at an oblique angle in the maxilla, in an apical direction, whereas in the mandible, the screws should be inserted as parallel to the roots as possible. Kyung et al, propose inserting implants at a 30-40° angulation to the long axes of the teeth in the maxilla, and 10-20° angulation in the mandible.

(2) Insertion method: Miniscres implants can be either self-drilling or non-self-drilling. The pilot drill for non-self-drilling should preferably be 0.3mm thinner, reaching no more than 2-3mm deep. Taking an intraoral radiograph with a surgical guide can significantly help for more accurate identification of the region of interest.

(3) Clinical procedures of implant insertion: Some basic guidelines for miniscrew implant placement follow: 1) a small amount of local anesthesia is usually sufficient, and it is advocated not to achieve profound anesthesia of the teeth but only of the soft tissue, 2) in case of non-self-drilling miniscrew implants, a pilot hole is necessary, 3) in case of self-drilling miniscrew implants, no incision or soft tissue removal is necessary.

(4) Loading and anchorage considerations: Orthodontic miniscrews are loaded immediately, and most authors suggest the use of light forces early on.

(5) Clinical procedure of implant removal: Usually, miniscrew implant removal is uneventful and the wound does not require any special treatment.

5. Complications:

(1) Inflammation, infection, and tissue irritation: One important factor to help avoid tissue inflammation is the determination of the best site for miniscrew implant insertion. It is advised that miniscrew implants should be inserted in keratinized gingiva when possible and that frenum and muscle tissue should be avoided.

(2) Injury to adjacent structures: The prognosis of the injured tooth depends on whether or not there has been injury to the pulp. In an animal study, almost complete healing of the periodontal structures was seen in a period of 12 weeks following removal of the screws.

(3) Failure: According to Miyawaki, the overall success rate for 16 month-follow up was 91%. The longer the miniscrew was, the higher the rate of success was. The location of the mini implants was found to be the only significant risk factor for failure, with miniscrew implants placed in the ramus having the highest failure rates.

(4) Fracture: In order to avoid fracture, it is advised that miniscrew implants should be used with a diameter of 2mm or larger. Fracture may also occur if the thread diameter of the miniscrew implant is less than 1.2mm thick.

Kuroda S, Sugawara Y, Deguchi T. Clinical use of miniscrew implants as orthodontic anchorage: Success rates and postoperative discomfort. Am J Orthod Dentofacial Orthop 2007; 131(1): 9-15.

Purpose: To evaluate the clinical usefulness of miniscrews as orthodontic anchorage.

Materials and Methods: Seventy-five adult human subjects (12 males, 63 females, average age= 22 years) with malocclusion participated in this study to evaluate the clinical usefulness of the miniscrew implant. All subjects were treatment planned for surgical placement of a skeletal anchorage to treat their malocclusion. At the start, subjects were informed of the possible risks and benefits of the procedure. Subsequently, subjects were randomly assigned to receive 1 of three types of implant anchors: 1)type A screws: diameter 2.0-2.3 mm, length 7 or 11 mm, and screw head 3 mm; 2) type B screws: diameter 1.3 mm, length 6, 7, 8, 10, and 12 mm, and screw head 3 mm; and 3) miniplates with 2 or 3 screws. Mucoperiosteal flaps were created to surgically expose the bone and place type A screws and miniplates. On the other hand, no effort was made to use mucoperiosteal flaps to place type B screws; instead, screw holes were made through the attached gingiva by using a self-tapping method with continuous irrigation (flapless surgery.) Miniplates and type A screws were not loaded until 4-12 weeks after implant placement. In contrast, loading of type B screws began 0-12 weeks after surgery. Loading forces were estimated to be between 50-200g. A minimplant screw was regarded to be a success if it survived 1 year following application of orthodontic forces. Subjects were then instructed to answer a retrospective questionnaire that used a 100-point visual analog scale (VAS). On a scale of 0 ("no discomfort") to 100 ("discomfort as much as it could be"), subjects were specifically instructed to score any pain, swelling, difficulty in chewing, speech difficulty, and difficulty in toothbrushing they experienced.

Findings: No statistically significant differences in success rates were noted between the three types of miniscrew implants. The average success rate for all three was over 80%.

On the other hand, significant differences were noted between the three types of miniscrew implants in terms of intensity of pain. VAS assessments of type B screws indicated that subjects experienced less pain (or discomfort) compared to subjects with either type A screws or miniplates. This was apparent by the observation that after 1 hour following surgery, VAS for both type A screws and miniplates was approximately 66% whereas the VAS for type B screws was approximately 19.5. In addition, significant differences were observed in the distribution of patients reporting pain. For instance, from day 0 to day 9, significant differences in the numbers of patients reporting pain were observed between type A and type B screws while from day 0 to day 14, significant differences were observed between subjects with type B screws and miniplates. The primary reason for differences in pain intensity and pain distribution may be possibly attributed to surgical flap reflection. Previous studies have speculated that postoperative pain is closely related to flap surgery.

Conclusions: All three types of miniscrew implants provide sufficient anchorage immediately after placement for any orthodontic tooth movement. Furthermore, the flapless surgical technique results in less pain and discomfort for patients, while, at the same time, as discussed above, provides for acceptable anchorage.

Huang LH, Shotwell JL, Wang HL. Dental Implants for orthodontic anchorage. Am J Orthod Dentofacial Orthop 2005;127:713-22. (58 refs.)

Purpose: The purpose of this article is to review and update current concepts of using dental implants for orthodontic anchorage from their inception in 1969.

Materials and Methods: Current literature to date, case reports and author's opinion are the basis for this article.

Findings and Conclusions: In orthodontic treatment, anchorage control is essential for success. Dental implants, due to the stability in bone, can serve as firm anchorage. The author's note 7 common orthodontic situations in which implants are indicated.

- Intrude or extrude teeth- mini implants (1.2mm in diameter and 6mm in length) are used as anchorage to intrude or extrude teeth. They are placed between roots or apical to a tooth. Care should be taken to avoid the PDL and to not place implants in mobile mucosa. The authors note that pure intrusion or extrusion cannot be achieved using mini implants. Mini implants are too small to cause irreversible damage and removal is generally uneventful.
- Close edentulous spaces- when treating spaces caused by congenitally missing teeth, reduced anchorage is generally a problem. Using implants in retromolar areas have been used to translate teeth into edentulous areas.
- Reposition malposed teeth- Adequate anchorage for tooth movement is often impossible when there are several missing teeth. Implants facilitate uprighting tilted abutment teeth, for example, in partially edentulous patients.
- 4) Reinforce anchorage- palatal implants have been developed to reinforce anchorage. Maximum anchorage can be achieved without using headgear or elastics. Palatal implants can be used in molar distalization successfully without destabilizing or rotating teeth traditionally used for anchorage.
- 5) Treat partial edentulism- Implants in edentulous areas are used to provide orthodontic anchorage and later serve as prosthetic abutments. Due to their low cost, the authors note that they are a great alternative to larger permanent more costly implants.
- 6) Correct undesirable occlusion- Correcting Class III anterior crossbite with conventional methods is not always satisfactory. Retracting the entire mandibular arch with dental implants is possible.
- 7) Provide orthopedic anchorage- palatal implants can be used to elicit palatal expansion in partially edentulous patients or in children with congenital anomalies or missing teeth.

Titanium alloys are considered the ideal material for implants. Sizes vary from the mini-implants (6mm long, 1.2mm in diameter) to standard dental implants (6-15mm long and 3-5mm in diameter). The most common implant shapes are cylindrical or cylindrical-conical, with a smooth or threaded surface. Studies have shown that the degree of surface roughness is related to the degree of osseointegration. Nevertheless, the dimensions of implants should be congruent with available bone and the treatment plan.

In 1995 Nobel Biocare developed a 2 stage implant system for orthodontic anchorage that was 10mm in diameter and 2mm thick. There were several drawbacks to this system. Various implants have been introduced since 1996 for palatal anchorage that have been proven effective. Biodegradable implants have also been introduced but more studies are necessary.

Surgical procedures for orthodontic implant placement is similar to standard implant surgery. If the implants are planned for future prosthetic abutments, a standard healing time should be followed. Because direct orthodontic forces generate less stress on implants due to limited force imposed (<3N, about 300g), they can be loaded immediately. jOrthodontic loads are continuous, horizontal, and usually 20-300 g. Occlusal loads are discontinuous, vertical, ans sometimes up to several kilograms. Complete osseointegration is favorable but not essential. It is also important to assess bone quality

at the time of implant placement, implant type (threaded vs cylindrical), and initial stability when determining when to load the implants. The loading regimen should be evaluated individually.

After surgery, the surrounding soft tissue should be monitored and maintained regardless of the implant type. If the implants are to be used afterwards as abutments, placement angulation and location is critical. If the implants are used for anchorage these criteria are far less important.

There are several disadvantages to using implants in orthodontic treatment such as cost, longer treatment time, and anatomical limitations. Nevertheless, dental implants have become predictable and reliable adjuncts to orthodontic rehabilitation.

Chen F, Terada K, Hanada K, et al. Anchorage effect on osseointegrated vs nonosseointegrated palatal implants. Angle Orthodontist 2006;76:660.

Purpose: To compare the anchorage effect of osseointegrated and nonosseointegrated palatal implants (NOPI) using finite element analysis.

Materials and Methods: 2 models were developed for this study. Model 1 was composed of 2 maxillary premolars, PDL, alveolar bone, a palatal implant, palatal bone, a bracket, band, and transeptal arch. The morphology of the premolars were designed according to the dimensions and morphology found in a standard dental anatomy textbook. The bracket, band, and transpalatal arch were combined as connected device. The PDL width was 0.25mm and the alveolar cortical bone was designed as 1mm. The implant designed was 3.3X9mm with an abutment 3mm long. The distance between the 2 premolars was 42.8mm from the center of the teeth. Palatal bone had a cortical surface thickness of 2mm, a cancellous thickness of 5.5mm and a cortical thickness of 1mm in the direction of the nasal floor. Model 2 was designed the same as model 1 with the exception of no implant or palatal bone. Bone-implant interfaces were treated as either fully boneded (osseointegrated) or frictional (nonosseointegrated). Force on the premolars were studied under 3 conditions: a distomesial horizontal force, a buccolingual horizontal force, and a vertical intrusiveforce. The magnitude of force was 5N. Stresses were calculated.

Findings No significant differences were noted between the left and right premolar. In each model, when a 5N distomesial horizontal force was applied, the highest stress was in the PDL at the cervical margin. The location of this stress was not changed by the implant. The stress decreased toward the apex. In model 2, the maximum PDL stress was 607.67kPa and the average PDL stress was 151.72kPa. The stress was reduced by more than 13% by the implant. When the premolars were subject to a 5N buccolingual horizontal force, the highest stress was in the PDL at the cervical margin. The stress decreased toward the apex. In model 2, the maximum PDL stress was 321.62kPa and the average PDL stress was 88.41kPa. The average PDL stress was reduced by about 60% by the implant. When the premolars were subjected to a 5N intrusive force was placed on the premolars, the highest stress was in the PDL at the cervical margin. The stress decreased toward the apex. The maximum and average PDL stresses for model 2 were 582.51 and 84.77kPa, respectively. The stress was reduced by 16% by the implant. When comparing the nonosseointegrated and the osseointegrated implant, the difference in maximum stress in a horizontal direction was less than 5%, while the maximum stress in the nonosseointegrated implant was far higher than the osseointegrated implant for the vertical force. The average stress was far higher in the nonosseointegrated than in the osseointegrated implant.

Direction of Force	Model 1 w/ OPI (% reduction in stress compared to Model 2)	Model 1 w/ NOPI (% reduction in stress compared to Model 2)	Model 2
Distalmesial			
MPS (kPa)	513.23 (15.46%)	509.24 (16.19%)	607.67
APS (kPa)	129.81 (14.44%)	131.25 (13.49%)	151.72
Buccallingual			
MPS	145.55 (54.74%)	147.35 (54.19%)	321.62
APS	35.11 (60.28%)	36.12 (59.14%)	88.41
Vertical intrusive			
MPS	487.21 (16.51%)	489.26 (16.01%)	582.51
APS	70.09 (17.31%)	71.02 (16.22%)	84.77

Maximum PDL Stress (MPS) and Average PDL Stress (APS)

Conclusions: By using finite element analysis, the presence of an implant significantly lowered the PDL stress of the 2 premolars. The osseointegrated and nonosseointegrated implants

showed the same anchorage effect, therefore it may be unnecessary to wait for osseointegration for an orthodontic implant.

Liou EW, Betty CJ, Lin JC. Do miniscrews remain stationary under orthodontic forces? Am J Orthod Dentofacial Orthop 2004;126:42-7.

Purpose: The purpose of this clinical cephalometric study was to answer this question and report the behavior of miniscrews under orthodontic loading.

Materials and Methods: Sixteen consecutive women who had miniscrews as anchorage for the en masse retraction of anterior teeth were included. Their ages ranged from 22 to 29 years old. The miniscrew was 2 mm in diameter and 17 mm in length. The implant site was the zygomatic buttress of the maxilla Cortical bone thickness is approximately 3 to 4 mm, and cancellous bone thickness is approximately 4 to 5 mm. However, its thickness varies on the pneumatization of the maxillary sinus. The miniscrews were inserted under local anesthesia. A 4-mm vertical incision was made with a #15 surgical blade at the mucogingival junction above the maxillary second premolar and first molar. A mucoperiostial flap was elevated to expose the zygomatic process of the maxilla. After the turning point of the zygomatic process of maxilla was located, a 1.5-mm spiral drill was used to drill a pilot hole under normal saline-solution irrigation.

The appliances for en masse anterior retraction were a .016 x .022-in stainless steel basal archwires with incisor lingual root torque, 2 lever arms for intrusion of the anterior teeth, and 4 Ni-Ti coil springs for en masses retraction. One Ni-Ti coil spring with a force of 150 g was attached between the miniscrew and the canine, and another with a force of 250 g was attached between the miniscrew and the hook on the basal archwire between the lateral incisor and the canine. The patients were seen at 1-month intervals.

Lateral cephalometric radiographs were taken 2 weeks after placement of the miniscrews (T1) and 9 months after placement of the en masse anterior retraction (T2).

The landmark screw tail was defined as the midpoint between the pointed tips of the right and left miniscrews; the landmark screw head was defined as the midpoint between the blunt ends (the end that fits onto the screwdriver); and the landmark screw body was defined as the midpoint between screw tail and screw head. The cephalometric tracings of T1 and T2 were superimposed for an average best fit among the anatomic structures of the maxilla, cranial base, and cranial vault. They were registered on sella and oriented on the anterior cranial base to obtain an anatomic best fit on the maxilla, with the outline of the cranial vault used for final confirmation. The vertical and horizontal changes from T1 to T2 at screw tail, screw body, and screw head were measured and analyzed. The miniscrews were also evaluated clinically for their horizontal mobility.

Findings and Conclusions: All patients tolerated the miniscrews well throughout the 9 months of treatment. Error analysis showed that there was no significant difference between the first and second measurements on the vertical and horizontal changes of the screw tail, the screw body, and the screwhead. The random errors of the vertical and horizontal measurements ranged from 0.0 to 0.3 mm. All 32 miniscrews remained stable clinically at T1 and T2. In 9 of the16 patients, the miniscrews were not displaced in any direction In the remaining 7 patients, the miniscrews were displaced during treatment. At the screw tail, the miniscrews were extruded and tipped forward to 1.0 mm forward. At the screw body, the miniscrews were extruded and tipped forward from 0.0 to 1.0 mm. At the screw head, the miniscrews were extruded and tipped forward from 0.5 to 1.5 mm.

This study showed that Miniscrews are a stable anchorage for orthodontic tooth movement but do not remain absolutely stationary like an endosseous implant throughout orthodontic loading. They might move according to the orthodontic loading in some patients. To prevent hitting any vital organs because of miniscrew displacement, it is recommended that miniscrews be placed in a non-toothbearing area that has no foramen, major nerves, or blood vessel pathways, or in a tooth-bearing area allowing a 2-mm safety clearance between the miniscrew and dental root.