Original Article

Surgical Difficulties, Success, and Complication Rates of Orthodontic Miniplate Anchorage Systems: Experience with 382 Miniplates

Y Findik, T Baykul, E Esenlik[1], MH Turkkahraman[1]

Departments of Oral and Maxillofacial Surgery and [1]Orthodontics, Faculty of Dentistry, Süleyman Demirel University, Isparta, Turkey

Abstract

Purpose: The aim of this study was to evaluate the complications and success rates of the miniplates using both maxilla and mandible for orthodontic anchorage in growing patients. **Materials and Methods:** One hundred and fifty-five consecutive patients (range 8.7–13.8 years) with Class II and III malocclusion without congenital or acquired deformities were included in this study. A total of 382 titanium miniplates were placed by the same surgeon. All miniplates were inserted under local anesthesia. Loading of the miniplates with a force of 200 g with the help of elastics or functional devices were initiated 3 weeks after surgery. **Results:** The overall success rate of miniplate anchorage in terms of stability was 96.8%. Twenty-one patients reported irritation of the mucosa of the cheeks or lower lip after the surgery in the mandible group. Twelve miniplates needed to be removed and were successfully replaced. **Conclusion:** Skeletal anchorage miniplates is effective for correcting malocclusions. Success depends on proper presurgical patient counseling, minimally invasive surgery, good postsurgical instructions, and orthodontic follow-up.

Keywords: *Miniplates, oral surgery, orthodontic anchorage*

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Introduction

Conventional orthodontics for the treatment of dental and facial skeletal discrepancies often involves intraoral appliances and extraoral appliances. In situations in which patients are partially edentulous or have oligodontia, the lack of teeth can often pose challenges for the orthodontist in devising a treatment plan with the existing dentition to provide sufficient anchorage.[1] Orthodontic anchorage is a term which explains the nature and degree of resistance to displacement offered by an anatomic unit. Anchorage is one of the important and factors in orthodontics, and its control is essential for successful treatment outcomes.[2] Implants and miniplates placed into the maxillo-mandibular skeleton enable the orthodontist to provide additional anchorage and exert predictable force in all three spatial planes transverse, vertical, and sagittal. There is a vast amount of literature on the use of anchorage devices in orthodontics to treat Class II and III malocclusion, malaligned teeth by uprighting, extrusion, intrusion, mesialization, and distalization. Traditionally, orthodontic therapy use teeth, extraoral and/or intermaxillary appliances for anchorage. For orthodontic anchorage, orthodontic implants (retromolar implants, miniscrews, pins, and palatal onplants) miniplates, fixation wires have been used frequently.[3] Over several years, bone-anchored orthodontic chin movement without corticotomy or osteotomy with the use of orthodontic elastics between miniplates in the upper and lower jaw was introduced.[4] Usually, different kinds of miniplates are inserted between the lateral and canine region in the mandible and the first molar region in the maxilla for skeletal anchorage for the treatment of various malocclusions. On the other hand, several problems such as loosening of the plates, inflammation, soft tissue changes, and fractures of the plates may be encountered during the surgical and orthodontic

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Address for correspondence: Dr. Y Findik, Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Süleyman Demirel University, Isparta, Turkey.
E-mail: yavuzfindik32@hotmail.com

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phases of treatment with these anchorage systems.[5,6] Therefore, the aim of the present study was to determine the surgical difficulties and the survival-failure rates of miniplates inserted both maxilla and mandible for orthodontic anchorage. Furthermore, strategies to prevent the complications will be discussed.

Materials and Methods

The study design and ethical considerations were approved by the Ethical Committee of Süleyman Demirel University, Faculty of Medicine, Turkey and an informed consent was signed by all patients' parents. No patients had any clefts, syndromes, or history of trauma. This study consisted of 155 patients who required skeletal anchorage during orthodontic treatment for the correction of Class II and III malocclusions in the Department of Orthodontics, Faculty of Dentistry, Süleyman Demirel University. A total of 382 miniplates were placed by the same surgeon. All miniplates were made of titanium, and different shapes of miniplates were used according to the orthodontic indications (Trimmed Orthodontic Miniplates, Ankara, Turkey).

Patients were classified into groups based on the clinical problem as follows:

- Class II malocclusion group: Two miniplates with attached functional appliances (Forsus) were inserted in the mandible for treatment of malocclusion (31 patients, 62 plates)
- Class III malocclusion group: Two different treatment options were applied to these patients. Treatment option 1: Two miniplates were inserted on the left and right infrazygomatic crest of the maxillary buttress and two miniplates were used between lateral incisor and canine bilaterally. A total of four miniplates were used in this group for applying excess forces to the jaws because of the patients advanced ages (36 patients, 144 miniplates)
- Treatment option 2: Two miniplates were inserted to the mandible as in the first group, between lateral incisor and canine bilaterally. The difference was in the maxilla where the mini implants were inserted between the maxillary second premolar and first molar area (88 patients, 176 miniplates).

Surgical technique

All operations were carried out under local anesthesia, and all miniplates were inserted by the same operator. Mucoperiosteal flaps were raised, and miniplates were inserted by two screws (2 mm diameter, 7 and 9 mm in length, if screws could not be tightened properly, 2.3 mm diameter and 5 mm length emergency screws were used). We generally used emergency screws in children under 10 years of age because of these patients bone thickness is not sufficient for primary stability.

In the maxilla, 1.5 cm horizontal incision was made parallel and 5–10 mm from the mucogingival junction, on the inferior crest of the zygomaticomaxillary buttress.

In the mandible, 10 mm long horizontal incisions about 5 mm above mucogingival junction were made. After mucoperiosteal flap elevation, miniplates were bent and adjusted to the bone surface, to achieve maximum bone contact. A space of 1.5–2 mm was left between the plate arm and the mucosa to avoid irritation of the soft tissues. Screws of 7 mm were inserted at the top of the plate and 9 mm in the lowest hole. The incisions were closed with sutures and removed on the 7th postoperative day.

Postsurgical instructions were given to all patients by the same surgeon and by the referring orthodontist. Oral antibiotics, analgesic, and mouth rinses were given after the surgery. Chlorhexidine mouth rinses were recommended from the 1st week after insertion and for 2 weeks, extensive rinsing with saline (NaCl) mouth rinse was also recommended to avoid soft tissue infection [Figure 1]. Three weeks after surgery, the miniplates were loaded. Orthodontic elastics and functional appliances (Forsus) were applied according to the treatment protocol for 3–6 months, with a loading force of about 200 g on each side.

Results

In 155 consecutive patients, 382 miniplates were placed with excellent primary stability under local anesthesia in both the maxilla and mandible without any damage to the adjacent structures. The root and tooth germs were evaluated with radiographic scans before and after the operations.

Nine-millimeter screws were only used in the mandible and inserted only the lower part of the plate holes where the bone thickness is very suitable for insertion. Placement surgery lasted on average between 10 and 15 min per a miniplate. Eleven soft tissue infections were seen around the plates after loading due to the bad oral hygiene (in mandible eight cases and in maxilla three cases). Twenty-one patients complained about the irritation of the mucosa of the cheeks or lower lip after the surgery in the mandible group. This complaint was easily solved by covering the fixation unit of the miniplate with a small piece of soft wax until edema of the soft tissues completely resolved. For avoiding plate arm soft tissue irritation especially when used self-bended plates, the direction of the plate arm could be bended upward [Figure 2]. On the other hand, in eight patients, plates were set into the mucosa and

Figure 1: Different kinds of miniplates used for orthodontic anchorage

Figure 2: Demonstration of the direction of self-bent plates. Note: Soft tissue irritation around the left miniplate arm

Figure 3: Intraoperative view of plate arm passed transmucosally underneath the mobile gingiva

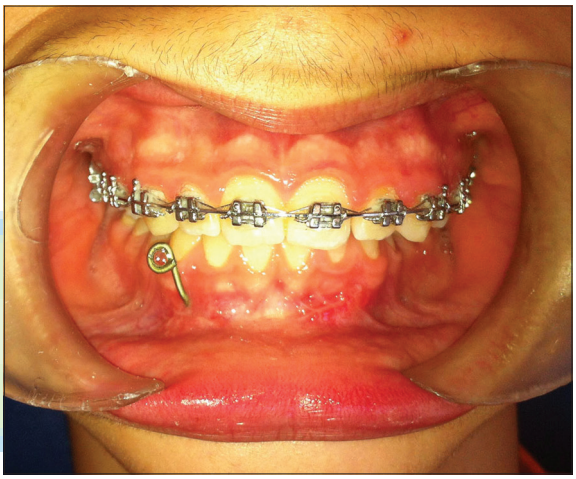

Figure 4: One plate arm fracture seen in Class II treatment group

patients could not use the elastics. In these patients, we elongated the plate arms by orthodontic wires and then patients used elastics easily without any complaints.

In the maxilla group, extensions (arms) of the plates passed mobile gingiva under the incision line transmucosally to avoid mucosa embedding during the postoperative healing period. By this technique, patients used elastics more comfortably without soft tissue irritation [Figure 3].

Twelve miniplates needed to be removed and were successfully replaced and inserted at the same time and after 3 weeks from the operation, patients used elastics. In these 12 failed miniplates, one plate arm fracture and 11 miniplate mobility (4 plates in the mandible and 7 plates in the maxilla) due to the soft tissue infection were seen. The plate arm fracture was seen in Class II treatment group [Figure 4]. In this patient, the broken plate was replaced with three holed miniplate and 3 weeks after the surgery, the patient used Forsus functional applience. In the maxilla, seven plates were replaced because of the mobility of the plates after loading. This complication was seen in patients with under the age of 9 because of the soft bone conditions around the infrazygomatic crest. Moreover, in the mandible, four plates were replaced because of the mobility due to the soft tissue infection or insufficient bone contact. Failed plates were changed at the same time with three holed plates and 3 weeks after the surgery patients used their appliances without any complication.

Discussion

Anchorage is one of the important factors in orthodontics, and its control is essential for successful treatment outcome.[2] Many types of anchorage devices are used in the orthodontic practice.[3] Miniplates have been shown to be well accepted as a skeletal anchorage in the literature and have turned out to be a safe and effective adjunct for complex orthodontic treatment.[7] On the other hand, surgical complications, the success-failure rate of different miniplates for orthodontic anchorage, has not been investigated as that of miniscrews, and research has been limited

to the application in both maxilla and mandible for various orthodontic treatments.[8-10] Miniplates have disadvantages like the inconvenience associated with flap surgery for installation and removal. Although this creates an additional discomfort for the patient, miniplates show greater stability than miniscrews and microscrews.[11] Stability is very important for applying excessive forces, especially in older patients. For miniplate insertion, sedation, general, and local anesthesia or acombination of these tecniques, are used according to treatment options. In literature, intravenous sedation or general anesthesia were generally used for orthodontic plate operations.[7,12] In our study, all of the surgeries was performed under local anesthesia and all patients well-tolerated the operation. On the other hand, this is the first study which utilized a large number of miniplates to determine the success rates in both maxilla and mandible.

Several loading periods were applied for the orthodontic anchorage systems. Immediate and 1, 2, or 3 weeks after the surgery are the loading choices of the plates in the literature. In a study, immediate loading led to the loss of a few of the systems installed.[13] In another study by De Clerck and Swennen, they suggested orthodontic loading of Bollard modified miniplates approximately 14 days after surgery.[6] Zygoma anchor systems were identified in a study, and these were fixed to the zygomaticomaxillary bone crest for buccal segment distalization. One week after surgery, the sutures were removed, and a distalization force of 450 g was applied on each side at the same time.[14] Screw stability after inserion was correlated with the remodeling of nonvital osseous margins surrounding the screw, which developed during surgical preparation and resulted in bone remodeling, a sequence of events including activation of osseous precursor cells, active resorption, and then formation.[12] Hence, the lowest level of screw stability was measured at 2 weeks, which might correspond to a phase where active resorption was predominant. If loading was allowed at this resorption phase, plate failure could occur. Thus, an undisturbed healing process for the first 3 weeks is a key factor for better stability. Decreasing the nonvital osseous margins when drilling the holes, screw holes might be drilled under saline solution irrigation for avoiding bone necrosis because it is very important for the bone healing process.

On the other hand, inflammation has been shown to be an important factor associated with miniplate failure.[15,16] The consequences of inflammation may lead to the early destruction of the surrounding bone tissue, which is essential for the mechanical interdigitation of the threads of the miniscrew. In the literature, antibiotic coverage appeared to be the preferred protocol after placement and removal surgeries. In a study, high success rates were seen without antibiotic prophylaxis. Concentration on surgical asepsis would probably further reduce the risk of introducing inflammatory pathogens at the surgical site.[17] Therefore, in our study group, loading was started 3 weeks after the surgery so as not to disturb the primary healing of the surrounding bone and to avoid any soft tissue inflammation in this period, mouth rinses were recommended during the 3rd week after placement. And also desired orthodontic movements were achieved by this technique.[18]

As to the timing of treatment, face mask protocol demonstrates the best outcomes in terms of maxillary protraction in the deciduous or early mixed dentition, possibly because of the lack of interdigitation of the circummaxillary suture at this early age, favoring the maxillary orthopedic response.[19] Thus, it typically is recommended that this therapy should be started before the age of 8 years when possible. In contrast, bone-anchored maxillary protraction is applied more successfully during the late mixed dentition or early permanent dentition because of lack of bone quality in the infrazygomatic arch needed for primary and secondary stability of the bone plates and screws at an earlier age. These surgeries are often delayed until after 10 years of age.[20] In our study, in the maxilla, seven plates were replaced because of the mobility of the plates after loading. This complication was seen in patients under the age of 9 probably as a result of the soft bone conditions around the infrazygomatic crest. To avoid this complication, bone cements can be used around the screws. Future studies may be focused on using bone cements around the anchorage units.

Several incision techniques are used for orthodontic miniplates insertion. L-shape, vertical, horizontal, and three edge envelope incisions were used for both maxilla and mandible operations.[7,14,17] In our study, in maxilla different from the literature, a 1–1.5 cm horizontal incision was made parallel and 5–10 mm from the border of the mobile and attached gingiva, on the inferior crest of the zygomaticomaxillary buttress. Soft tissue inflammation and plate arm impaction were avoided during the healing period by extending the arms of the plates underneath the mobile gingiva and under the incision line transmucosally. In the mandible, horizontal incisions below and parallel to the mucogingival junction was adequate for both insertion and adaptation of the plates. Self-bent miniplates in the mandible required that the plate arm direction could be placed upward to also avoid soft tissue complications. When horizontal

incisions were used in both the maxilla and mandible on the mobile gingiva, sufficient bone exposure was achieved for adjusting and inserting the miniplates and also vestibular sulcus depth was protected.

In the Class II group, one plate arm fractured, and three plate failure were seen in our study. The fracture may be due to the very long extension of the plate arm and insufficient metallic fusion between the plate body and plate arm. The long elongations of the plate arm during function resulted in extensive forces being applied to the neck of the plate, and this may have resulted in the fracture and failure in this group. This study demonstrated that when miniplates with three holes and unique font miniplates without any connections between the plate body and the arm, are used, functional appliances (Forsus) may be used without any complications. On the other hand, in the literature, failure of miniplates are generally replaced under local anesthesia 3 months after their surgical removal.[6,8] In our study, the three hole miniplates were inserted following the removal of the failed plate at the same operation, and orthodontic treatment was not delayed because the miniplates were used without any complication.

Conclusion

Surgery to insert miniplates can be performed under local anesthesia without any complications. The horizontal incision has the better advantage in that sufficient bone exposure enables the clinician adjust and insert the miniplates conveniently and also protects the vestibular sulcus depth. Finally, miniplate success depended on proper plate selection which is dependent on the type of malocclusion and required applied force.

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Conflicts of interest

There are no conflicts of interest.

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