Patient's Perception of Pain in Treatment with Temporary Anchorage Devices (Micro-implant, Mini-implant and Mini-plate): Intragroup and Intergroup Analysis

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Abstract

Currently, temporary anchorage devices (TADs) are being used in orthodontic treatments for skeletal anchorages. However, patients remain apprehensive regarding the use of this novel concept in orthodontic procedures. The purpose of this study was to compare the differences and the change in pain perception after treatment using TADs (micro-implant, mini-implant and mini-plate).

Fifty-seven TADs (20 micro-implants in the infrazygometic crest, 19 mini-implants in the posterior paramedian palate and 18 mini-plates in the infrazygometic crest) were inserted as skeletal anchorages. The visual analog scale (VAS) was used to evaluate and compare the patients' perception of pain for 3 TADs procedures. The repeated-measure general linear model (GLM) was used in the analysis of intragroup. One-way ANOVA was applied to analyze the data from intergroup and followed by the Tukey's HSD (honestly significant differences) test for post hoc comparisons.

One day VAS after TADs placement, mini-implant group (56.8) and mini-plate group (59.5) were significant greater than micro-implant group (30.8) and no difference between mini-implant group and mini-plate group. Seven days VAS after TADs placement, mini-plate group (27.2) and mini-implant group (10) weren't significant than micro-implant group (17). However, mini-plate group were significant greater than mini-implant group.

The TADs could enhance the effectiveness and efficiency of orthodontic treatment, and the patients could endure the pain and discomfort during the TADs treatment.

Key Words: Temporary anchorage devices, Pain perception, Visual Analog Scale, Mini-implant, Mini-plate

Introduction

Anchorage control is the keystone to success in orthodontic treatment. Numerous techniques and devices have been developed to reinforce anchorage control. Traditional devices, such as the multibracket appliance, active corrector, and extraoral headgear, still cannot effectively control anchorage. Therefore, orthodontists' search for a new device for anchorage control has continued. In 1983, Creekmore and Eklund [1] inserted a mini-implant (bone screw) in the anterior nasal spine and successfully intruded the maxillary incisors. In 1985, Jenner and Fitzpatrick [2] first used a bone mini-plate as orthodontic anchorage to retract mandibular molars.

Above all, skeletal anchorage concept to control tooth movement become great emphasis in alternative orthodontic anchorage. Therefore, the newly developed temporary anchorage devices (TADs) that have a smaller diameter, require less time for osseointegration, and are available at a lower cost, have recently been introduced for orthodontic treatment [8-10]. TADs are temporarily fixed to bone for the purpose of enhancing orthodontic anchorage and intended to be removed at the end of their active use. Moreover, innovations [2,3] of TADs have been introduced in the micro-implant (diameter 1.5 mm), mini-implant (2 mm) and mini-plate system for requirement of alternative anchorage.

Pain is an unpleasant sensation associated with tissue damage and reaction. It is common among patients who have suffered from pain after initial orthodontic appliance insertion. As a matter of fact, pain is a combination of complex experiences that can be influenced by the patient's age, sex, emotions, psychology, and the memories of past pain experiences. Surely, a new TAD operation may trigger the patient's fear of the unknown. Therefore, it is important to take into consideration the pain experienced by patients during the TADs treatments. In this study, we investigated the perception of pain (Visual Analog Scale) in patients and provide more information on communicating with patients.

Methods

Twenty micro-implants, 19 mini-implants and 18 mini-plates were implanted in 57 patients for TADs in orthodontic treatment *(Table 1)*. One TAD was placed in one patient. First, the orthodontic fixed appliance was inserted without medication. After a 3-week interval, all patients were fully informed about TADs procedures. Under pilot drilling, micro-implant (Lomas®, Mondeal, Tuttlingen, Germany) was inserted in the infrazygomatic crest with a 1.5 mm in diameter and 11 mm in length. Under pilot drilling, mini-implant (Bioray®, Bio-Ray Biotech Corp, Taipei, Taiwan) was locked in paramedian palate with a 2 mm in diameter and 8 mm in length. Under flap operation, mini-plate (Leibinger and Mühlheim-Stelten, Germany) was placed into the infrazygomatic crest with 2 mini-implant (diameter: 2 mm; length : 5 or 7 mm). For each patient, antibiotics and nonsteroidal antiinflammatory drugs (NSAIDs) were prescribed at 8-h intervals for 3 day.

The questionnaires contained a 100-mm visual analog scale (VAS) to measure the perception of pain during treatment and consisted of the 4 following questions:

- How much pain did you have at a day after the fixed orthodontic appliance insertion?
- Before TADs placement, how much pain did you expect?

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- How much pain did you have at 1 day after TADs placement?
- How much pain did you have at 7 days after TADs placement?

In the analysis of intragroup, repeated-measure general linear model (GLM) was used to compare 4 questionnaires for differences in pain levels and multiple pairwise comparisons was selected for post hoc test. One-way ANOVA was used to analyze the data from intergroup and followed by the Tukey's HSD (honestly significant differences) test for post hoc comparisons. Data was analyzed using SPSS version 14 (SPSS Inc, Chicago, IL). Significance was pre-determined at p value less than 0.05.

Results

The gander proportion was similar in 3 groups, with a female: male ratio of 16:4 in micro-implant group, 17:2 in mini-implant group and 15:3 in mini-plate group *(Table 1)*. The mean age of patients was 26 in micro-implant group, 27.6 in mini-implant group and 26 in mini-plate group. The data in comparison of patient's pain perception among the TADs was shown in the *Table 1*. In the analysis of intragroup, repeated-measure GLM revealed significant in all groups. In post hoc test, multiple pairwise t test in 4 questionnaires (Q1 to Q4) showed significant in micro-implant group (Q1>Q4, Q2>Q1, Q2>Q3, Q2>Q4, Q3>Q4), in mini-implant group (Q1>Q4, Q2>Q1, Q2>Q4, Q3>Q1, Q3>Q4), and in mini-plate group (Q1>Q4, Q2>Q1, Q2>Q4, Q3>Q1, Q3>Q4).

Table 1. The descriptive data of temporary anchorage devices (TADs) in maxilla.

Type of devices	Micro-implant	Mini-implant	Miniplate
Gender (Female/ Male)	(16/4)	(17/2)	(15/3)
Age (Mean/ Range)	(26/19 to 42)	(27.6/18 to 47)	(26/19 to 41)
Number of TAD	20	19	18
Locations of devices placement	Infrazygomatic crest	Paramedian Palate	Infrazygomatic crest
Dimensions of TADs			
Number of implant	1	1	2
Length (mm)	11	8	5 or 7
Diameter (mm)	1.5	2	2

According to the analysis of intergroup, there is no significant difference in gender and age. In the analysis of intergroup, one-way ANOVA showed no significant difference among micro-implant (mean VAS=38.5), mini-implant (mean VAS=47.3) and mini-plate groups (mean VAS = 35.8) in 1 day after insertion of the fixed appliances *(Table 2)*. Due to fear of TADs procedures, patient's pain perception was aggravated. The mean anticipative VAS scores were significantly increased in each groups (micro-implant: 57.8; mini-implant: 61.1; mini-plate: 70.3). However, there is still no significant difference in the analysis of intergroup.

Table 2. The visual analog scale (VAS) of pain in the TADs of orthodontic treatment.

Type of devices	Micro-implant	Mini-implant	Miniplate
Mean pain intensity (n=VAS)*			
Q1: 1 day VAS after fixed orthodontic appliance insertion	38.5 ± 19.8	43.7 ± 21.1	35.8 ± 17.3
Q2: Expect VAS from TADs placement before surgery	58.75 ± 24.7	61.1 ± 18.3	70.3 ± 21.1
Q3: 1 day VAS after TADs placement	30.75 ± 17.6	56.8 ± 27.0	59.5 ± 17.6
Q4: 7 days VAS after TADs placement	17 ± 14.4	10 ± 16.2	27.2 ± 11.9

In one-way ANOVA analysis, there was significant difference in 1 and 7 days after TADs procedures. In 1 day after TADs procedures, Tukey's HSD post hoc test showed that micro-implant group (VAS=30.8) was significantly less than mini-implant group (VAS=56.8) and mini-plate group (VAS=59.5). However, there is no significant difference between mini-implant group and mini-plate group. In 7 days after TADs procedures, Tukey's HSD post hoc test showed that mini-plate group (VAS=27.2) was significant greater than mini-implant group (VAS=10). Comparing to micro-implant, mini-implant and mini-plate showed no significant difference.

Discussion

Orthodontic pain is the most frequent complaint of patients and is also an important communication among patients, parents, and doctors. Based on a literature [4-6] review, most patients complained of pain during orthodontic treatment. Several researchers [5,6] have reported that peak pain intensity was observed 24 h after the insertion of orthodontic fixed appliances and mean VAS score could exceed more than 50. The pain intensity gradually reduced to normal levels 7 d after the insertion. In our study, the VAS score was similar to that reported in these studies, i.e., the VAS was 38.5 in the micro-implant group, 47.3 in the mini-implant group and 35.8 in the mini-plate group. Intergroup analysis revealed no significant difference.

New orthodontic treatment modalities that involve the surgical placement of a TAD could particularly intensify a patient's fear of operation. It is no wonder that pre-surgical anticipated pain had VAS scores were significant increased in all groups. Even no flap operation in the micro-implant and mini-implant groups, pre-surgical fears were created equally without significant difference in analysis of intergroup (micro-implant: 57.8; mini-implant: 61.1; mini-plate: 70.3). Therefore, the patient's expectations and the actual pain

experienced are very important to the surgeon, orthodontist, and the patient himself.

Owing to the flap operation in the mini-plate group (VAS=59.5), its VAS was greater than the micro-implant group (VAS=30.8) and mini-implant group (VAS=56.8) at 1 day post-operation. Moderate postoperative facial swelling was frequently observed in the mini-plate group and gradually subsided within a week. After palatal mini-implant insertion, tongue was easy to irritate and presented a similar high VAS score as mini-plate group. Due to smaller diameter and without flap operation, Tukey's HSD post hoc test showed that micro-implant group was significantly less than mini-implant group and mini-plate group. In our patients, all TADs were performed with pre-drilling. Lehnen et al. [7] reported that patients tolerated the various mini-implants insertion procedures (pre-drilling and self-drilling) equally well without significant.

In 7 days after TADs procedures, Tukey's HSD post hoc test showed that mini-plate group (VAS=27.2) was greater than micro-implant group (VAS=17) and significant greater than mini-implant group (VAS=10). Investigation to determine the cause of greater pain in the mini-plate group, there were more postoperative discomfort and swelling due to flap operation. Compared to 1 day post-operation, mini-implant group was lower than micro-implant group and it means that tongue adapt well in irritation than cheek after 7 days. However, there is no significant difference between micro-implant group and mini-implant group.

Regarding VAS in the researches of micro- implant operation, most of them were placement in the interdental area of molar area, not in the infrazygomatic crest (our study). In English's literature, there is the only VAS report concerning mini-implant (diameter: 2 or 2.3 mm; length: 7 or 11 mm) in infrazygomatic creat by Kuroda et al. [8]. They also founded that postoperative VAS following mini-implant placement were decreased significant decreased form 1-day (40) to 7-day (10). Our finding (Q3>Q4) was similar to Kuroda et al. [8]. In the interdental micro-implant researches, Lee et al. reported that 1-day VAS following archwire initial alignment (44.4) was greater than elastics separation (23.9), premolar extraction (30.8) in the traditional orthodontic procedures. Compared to traditional orthodontic procedures, Lee et al. [9] found that 1-day VAS following interdental micro-implant operation showed no difference. Patient's VAS was decreased significantly from 1-day (36.6) to 7-day (11.3) following micro-implant operation and no significant difference to traditional orthodontic procedures. In repeated-measure GLM and post hoc test, we founded that 1-day postoperative pain following micro-implant placement (Q3) was no difference to fixed appliance insertion (Q1). This founding was similar to Lee et al. [23]. This information is very important and easy to let patients know and avoid overestimating the pain anticipated with micro-implant operation.

A number of reports [10,11,12] have since shown that palatal implants are an excellent option for extra-oral anchorage. Although Onplant (diameter: 7.7 mm, Nobel Biocare, Gotenberg, Sweden) and Orthosystem palatal implants (diameter: 3 mm, Straumann, Basal, Switzerland) have a high success rate, they require a flap operation for their insertion and removal because of their larger diameter. Moreover, Onplant and Straumann's palatal implants were commonly applied in the anterior palate and not in the posterior palate (our study). Kang et al. [13] used computed tomography to evaluate the thickness of the palatal bone for orthodontic mini-implant placement. The thickest bone (>5 mm) was found in the anterior palate, median suture, and paramedian areas. The midpalatal area, within 1 mm of the midsagittal suture, had the thickest bone in the whole palate. The thickness tended to decrease laterally and posteriorly. There was a significant difference in thickness between the male and female groups, where males had greater mean values for most of the areas near the posterior midsagittal palate.

Recently, a smaller diameter palatal mini-implant (2 mm) has been developed for direct insertion rather than flap surgery. In the English's literature, there is no report regarding patients' anticipated and experienced pain in the posterior paramedian palatal implant operation. In the analysis of mini-implant intragroup, post hoc test revealed that patients' anticipated pain (Q2) and 1-day pain experienced (Q3) presented no significant different. It means that 1 day following palatal mini-implant operation (Q3) caused significant pain than fixed appliance insertion (Q1). Fortunately, patient's VAS was decreased significantly from 1-day (56.8) to 7-day (10) following palatal mini-implant operation.

Cornelis et al. [14] reported that 82% of patients experienced mini-plate operation better than expected, with little or no pain. The most frequent problems were postsurgical swelling, lasting 5 days on average, and cheek irritation experienced initially by more than a third of the patients, but it lessened over time. In the analysis of mini-implant intragroup, post hoc test revealed that patients' anticipated pain (Q2) and 1-day pain experienced (Q3) presented no significant different. It means that 1 day following mini-plate operation (Q3) caused significant pain than fixed appliance insertion (Q1). Kuroda et al. [8] reported that 1-hour postoperative VAS was reached to highest score (66.4) in the mini-plate surgery and decreased significant decreased form following 1-day (40) to 7-day (10). Our finding was similar to Kuroda et al. [8] and VAS was decreased significantly from 1-day (60) to 7-day (27.2).

Conclusions

The role of the TADs in orthodontic treatment is as a coadjutant to improve the efficiency and effectiveness of the treatment. While introducing a new treatment modality, the doctor and patient should discuss the various types of treatment modalities very carefully. Any pain and adverse complications would attenuate the outcome of the new treatment modality. Doctors should not only focus on the efficiency of a treatment but should also be aware of the discomfort experienced by patients. Patients need to obtain timely information regarding a new method in order to eliminate their apprehensions. From our investigation, we obtained proper data to approach the patient-centered point of view and the patients could endure the pain and discomfort during the TADs treatment.

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