

The impact of osteotomy technique for corticotomy-assisted orthodontic treatment (CAOT) on oral health-related quality of life

M. CASSETTA, S. DI CARLO, M. GIANANTI, V. POMPA, G. POMPA, E. BARBATO

Department of Oral and Maxillofacial Sciences, School of Dentistry, Sapienza University of Rome, Rome, Italy

Abstract. – **BACKGROUND:** Corticotomy in accelerating orthodontic tooth movement, also defined as corticotomy-assisted orthodontic treatment (CAOT), is a promising technique that recently had many applications in orthodontics.

AIM: The purpose of this study was to compare the use of piezoelectric surgery and conventional rotatory osteotomy technique for CAOT, determining the duration of surgery and oral health-related quality of life (OHRQoL).

PATIENTS AND METHODS: CAOT was performed in a sample of subjects, randomly choosing piezoelectric surgery (PS Group) or conventional rotary osteotomy technique (RT Group). The duration of surgery was recorded and the oral health-related quality of life evaluated using the short form Oral Health Impact Profile (OHIP-14) preoperatively, 3 and 7 days after surgery. *t*-test and Cronbach's alpha were used for statistical analysis.

RESULTS: 12 patients (mean age 14; range: 13-17) were enrolled. The time needed to complete the osteotomy cuts was greater ($p = 0.1$) for the piezoelectric surgery group (mean 34.3 minutes; range 35.3-32.6) than for the rotator group (mean 28.2 minutes; range 27.1-29.2).

Oral health-related quality of life deteriorated from baseline (OHIP-14 mean: 6.33) to first follow-up, 3 day after surgery, in both groups (PS Group: 22.67 OHIP-14; RT Group: 21.33 OHIP-14). At 7 days follow-up there was a nearly complete recovery of the original OHIP-14 values, even faster with the conventional rotary osteotomy technique; however, no statistically significant differences were recorded between the two methods ($p = 0.35$). Cronbach's alpha values indicated an excellent internal consistency reliability.

CONCLUSIONS: In clinical decision-making regarding the use of corticotomy-assisted orthodontic treatment, it should be aware of the expected decrease in oral health-related quality of life both using piezoelectric surgery or rotary osteotomy technique. In addition, the piezoelectric osteotomy requires a longer surgical time.

Key Words:

Corticotomy-assisted orthodontic treatment, Orthodontic tooth movement, Oral health-related quality of life, OHIP-14.

Introduction

The accelerating orthodontic tooth movement and the resulting shortening of the treatment duration would be quite beneficial¹. Corticotomy, as defined by Long H. et al¹, consists of small perforations on the alveolar bones along the way by which the tooth would be moved.

This technique is relatively safe and it is an effective intervention to accelerate orthodontic tooth movement¹.

Corticotomy in accelerating orthodontic tooth movement, also defined as corticotomy-assisted orthodontic treatment (CAOT)², is a promising technique that recently had many applications in orthodontics.

Corticotomy cuts can be made using piezoelectric surgery or conventional rotatory osteotomy.

It has been suggested that the use of ultrasonic devices might cause less postoperative pain and discomfort because this technique is less traumatic to the hard and soft tissues³.

An histological study showed that piezosurgery provides more favorable osseous repair and remodeling than carbide or diamond burs when surgical osteotomy and osteoplasty procedures are performed⁴⁻⁷.

At present, the use of piezoelectric instruments seem to have several advantages: reduction of intraoperative bleeding and surgical trauma, and improved intraoperative visibility⁸.

Moreover, this alternative approach reduces not only the complications of the surgical technique but also the operating time and therefore the morbidity of the patient⁹. However, the time factor seems to depend on the bone structure and thickness, and the duration of the osteotomy procedure can be increased by up to fivefold when compared with conventional osteotomy devices¹⁰. Therefore, literature data are conflicting and based on few articles^{3,5,8-10}.

Several studies have investigated the patients' perception of consequences of oral surgical procedures and these were primarily focused on the frequency and duration of pain, mobility impairment, sensory disturbances, and intra- or post-operative complications^{3,11}.

A standardized and well-accepted concept for the assessment of patients' perceptions of oral health-related impairments are measures of oral health-related quality of life (OHRQoL)¹².

Oral health-related quality of life (OHRQoL) is part of QoL and has been used to measure how different oral health conditions affect quality of life¹². Measuring differences in QoL by "units of quality of life" it is possible to compare the benefits or burdens of different treatments and to show a non-clinical person what morbidity in the figurative sense means¹²⁻¹⁴.

To our knowledge, the use of patient-centered outcome scales has only recently been used in orthodontics¹⁵⁻¹⁷.

The aim of the present clinical study was to compare the use of piezoelectric surgery and rotatory osteotomy technique for CAOT. To date, there has not been published on patients' perceptions on quality of life and risk factors for severe discomfort after CAOT.

The study hypothesis was that piezosurgery would be more suitable than rotatory drilling for osteotomies in terms of the duration of surgery and influence on OHRQoL.

Patients and Methods

To address the research question, the Investigators implemented a randomized, prospective clinical study. The treatment method (piezoelectric surgical device or multi-blade tungsten carbide bur fitted on a highspeed handpiece) was randomly assigned to each subject using a computer-generated randomization list. All the surgical and orthodontic procedures were completed by the same operator, expert in oral surgery and orthodontics (MC).

The subjects considered were selected from July 2011 to June 2012. The main inclusion criterion was the presence of a bilateral I class molar malocclusion with a moderate-severe crowding or/and monolateral crossbite. The subjects were adolescents (age range: 13-17 years) undergoing orthodontic treatment in whom corticotomy was indicated to facilitate their treatment. The exclusion criteria were individuals with sys-

temic diseases or history of treatment for psychiatric problems, presence of caries, extensive periodontal disease, pain or inflammatory symptoms at the time of treatment.

All subjects and their legal guardians gave their written informed consent for the procedures. The local Ethical Committee approved the study protocol. We have read the Helsinki Declaration and followed the guidelines in the present investigation.

After consenting to participate in the study, the following data were recorded: name, age, gender.

For each subject, immediately before the surgery, the osteotomy method (piezoelectric surgery or conventional rotatory osteotomy) was randomly selected.

All subjects used a mouthwash containing 0.2% chlorhexidine for 1 minute preoperatively.

Next, plexus anesthesia was obtained using carbocaine 2% with epinephrine 1:100,000 as local anesthetic.

In all cases a sulcular incision was made and a full-thickness flap was reflected on buccal aspect of all maxillary or mandibular teeth, from the medial margin of the second right molar to the medial margin of the second left molar without releasing incisions. After detaching the flap, the cortical bone was exposed and the osteotomies were performed. Flaps were carefully reflected beyond apices of the teeth. Care was exercised not to damage any of the neurovascular bundles exiting the bone. Following flap reflection, vertical corticotomy cuts between the roots of the teeth, stopping just short of the alveolar crest, were performed. Numerous corticotomy perforations were made in the cortical layer. Interproximal corticotomy cuts were extended through the entire thickness of the cortical layer, just barely penetrating into medullary bone. The design of the selective decorticating (vertical cuts or perforations) was finalized to maximize the marrow penetration and bleeding than to create blocks of bone. In the piezoelectric surgery group (PS Group) the osteotomy was performed with the piezosurgical device (Easy Surgery, BioSAF, Assago, Milan, Italy), using the insert 511 to realize vertical cuts and the insert 514 to realize corticotomy perforations (Figure 1). In the conventional rotary osteotomy technique Group (RT Group), the osteotomy was performed with round multi-blade bur fitted on a highspeed handpiece (CB1.316.018; D+Z, Germany) (Figure 2). The procedure was then completed with repositioning of the flap and suturing with Vicryl 3.0 thread (Vicryl Ethicon, Johnson & Johnson, Somerville, NJ, USA).



Figure 1. Flap reflection and vertical corticotomy cuts between the roots of the teeth, using insert 514 to perform the cortical perforation.

The surgical time (time needed to complete the whole procedure, from the incision of the full-thickness flap to the suturing) was recorded in all cases.

The orthodontic force was applied on the teeth with a fixed orthodontic appliance at the end of suturing. All subjects completed the same post-operative protocol for both corticotomy methods. This protocol included antibiotic therapy with amoxicillin/clavulanic acid, 1 g in 2 daily doses for 5 days (Augmentin; Glaxo-SmithKline, Verona, Italy).

Oral Coeffergan (paracetamol 500 mg with codeine 30 mg; Bristol-Myers Squibb, Sermone-ta, Italy) was immediately given after the cortico-



Figure 2. Corticotomy cuts using a round multi-blade bur fitted on a highspeed handpiece.

tomy and was prescribed to be taken as required for pain relief (maximum 6 tablets daily).

Patients were instructed not to take any drugs other than those prescribed. Patients were also advised to take the analgesic tablet as soon as their pain reached a moderate level.

Patients were given the usual postoperative instructions.

The day after surgery, subjects began the use of the chlorhexidine solution (15 ml of 0.2% chlorhexidine solution) twice a day for 1 week (Dentosan; Pfizer Consumer Healthcare, Rome, Italy).

The sutures were removed at the first follow-up visit 7 days after the surgical procedure.

Oral health-related quality of life was assessed using the Italian version of short-form oral health impact profile (OHIP-14)¹⁸ with 14 questions, which represents seven dimensions of OHRQoL: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.

The OHIP-14 contains questions that retain the original conceptual dimensions contained in the OHIP, suggesting the instrument should be useful for quantifying levels of impact on well-being in settings where only a limited number of questions can be administered¹⁹.

All subjects received the OHIP with 14 questions questionnaire, after being instructed in its use.

In the ward, the self-administered questionnaire was filled out by the patients preoperatively (baseline), 3 (T1) and 7 days after surgery (T2).

Responses were made on an ordinal 5-point adjectival scale (0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, 4 = very often). OHRQoL is characterized by summary scores of the OHIP-14 items. Higher scores indicate a stronger negative influence on OHRQoL.

Statistical Analysis

Data were entered into a spreadsheet (Excel; Microsoft, Inc, Redmond, WA) over the course of the study. SPSS[®] software (Statistical Package for Social Science, IBM Corporation, NY-USA) was used for statistical analysis.

Quantitative data of two groups were described with frequency distribution, mean values and range of values.

t-test was used to determine the difference in duration of surgery between the two different osteotomy techniques (piezosurgery vs. conventional rotator osteotomy). Significance was set to $p \leq .05$.

t-test was also used to determine the influence of surgical technique (piezosurgery vs. conventional rotator osteotomy) on OHIP-14 scores. Once again, significance threshold values were set to $p \leq .05$.

The internal consistency of the scale, which means that each domain of the instrument assesses distinct aspects of the same attribute or construct, was evaluated using Cronbach's alpha.

Results

A total of 12 subjects were enrolled (4 males and 8 females, aged from 13 to 15 years; mean age: 14). All required corticotomy for orthodontic purposes. To perform CAOT, piezoelectric surgical device was used in 6 subjects (50%) and multi-blade tungsten carbide bur fitted on a high-speed handpiece was used in 6 subjects (50%).

CAOT involved the maxillary arch in 8 cases (66.7%) and the mandible (33.3%) in 4 cases.

Postoperative healing was uneventful and free of complications in all patients.

The mean time necessary for the osteotomy procedures with the piezoelectric device was 34.3 minutes (range 35.3-32.6) while with the conventional rotator osteotomy was 28.2 minutes (range 29.2-27.1).

The piezosurgical procedure took longer to complete than the conventional rotator osteotomy, but the difference was not statistically significant ($p = .1$).

OHRQoL deteriorated from baseline (mean: 6.33 OHIP-14; range: 0-14) to first follow-up, 3 day after surgery, in both groups (PS Group: 22.67 OHIP-14 mean; range: 7-45; RT Group: 21.33 OHIP-14 mean; range: 16-26) (Table I). At 7 days follow-up there was a nearly complete recovery of the original OHIP-14 values (PS Group: 16.33 OHIP-14 mean; range: 2-25; RT Group: 10.67 OHIP-14 mean; range: 5-22), even more rapid in the conventional rotary osteotomy technique.

However, on the basis of our statistical analysis, the osteotomy technique variable, considered in the paired comparisons, did not significantly modified the OHIP-14 scores at baseline ($p = .272$), and at 3 ($p = .862$) and 7 ($p = .352$) days of follow-up.

Table I. Question and score for the OHIP-14 at T1 (PS-Group).

	Mean	Standard deviation	Cronbach's alpha
Have you had trouble pronouncing any words because of problems with your teeth or mouth?	1.00	1.549	.963
Have you felt that your sense of taste has worsened because of problems with your teeth or mouth dentures?	1.33	1.366	.967
Have you had painful aching in your mouth?	2.33	1.366	.963
Have you found it uncomfortable to eat any foods because of problems with your teeth or mouth?	2.33	1.366	.963
Have you been self-conscious because of your teeth or mouth?	1.67	1.862	.966
Have you felt tense because of problems with your teeth or mouth?	1.33	2.066	.963
Has your diet been unsatisfactory because of problems with your teeth or mouth?	1.67	.516	.972
Have you had to interrupt meals because of problems with your teeth or mouth?	2.33	1.862	.977
Have you found it difficult to relax because of problems with your teeth or mouth?	2.67	2.066	.973
Have you been a bit embarrassed because of problems with your teeth or mouth?	1.00	1.549	.963
Have you been a bit irritable with other people because of problems with your teeth or mouth?	1.00	1.549	.963
Have you had difficulty doing your usual jobs because of problems with your teeth or mouth?	1.00	1.549	.963
Have you felt that life in general was less satisfying because of problems with your teeth or mouth?	1.00	1.549	.963
Have you been totally unable to function because of problems with your teeth or mouth?	1.00	1.549	.963

Responses are made on a 5-point scale, coded 0 = never; 1 = hardly ever; 2 = occasionally; 3 = fairly often; 4 = very often. (Modified from Slade G.D. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol 1997; 25: 284-90).

Table II. *t*-test regarding the difference in OHIP-14 scores between the piezoelectric surgery group (PS-group) and conventional rotary osteotomy technique group (RT-group) at baseline, and at 3 and 7 days of follow-up.

		Difference between means		
		Sig.	Means	Standard error
PS group vs RT group	Baseline	.272	4	3.43
PS group vs RT group	T1	.862	1.33	7.48
PS group vs RT group	T2	.352	5.66	5.8

Cronbach’s alpha values indicated in all self-administered questionnaires an excellent internal consistency reliability.

Discussion

In the present study, 12 subjects were treated by corticotomy-assisted orthodontic treatment (CAOT).

CAOT involves selective alveolar decortication in the form of decortication lines and dots performed around the teeth that are to be moved. It is done to induce a state of increased tissue turnover and a transient osteopenia, which is followed by a faster rate of orthodontic tooth movement². The surgical instruments used to realize corticotomy cuts were the piezoelectric device and traditional method using the microdrill. Our sample was homogeneous in terms of the subjects’ age and degree of dental malocclusion.

To date, several novel modalities have been reported to accelerate orthodontic tooth movement, including low-level laser therapy, pulsed electromagnetic fields, electrical currents, distraction osteogenesis, and mechanical vibration, but only corticotomy showed consistent results accelerating the orthodontic tooth movement¹.

In a recent review of literature, Long et al¹ stated that corticotomy is safe and able to accelerate orthodontic tooth movement, but only two studies were considered eligible.

Piezosurgery is a recently developed system for cutting bone with microvibrations which uses low frequency ultrasonic waves (24.7-29.5 kHz), the machine is programmed in accordance with the density of the bone and works only on mineralized hard tissue, not on soft tissue. During the osteotomy, the use of ultrasonic techniques has advantages over other conventional instruments, including a highly precise cut geometry without the need for excessive force and efficient bone ablation, minimizing the risk of accidental damage to soft tissues and therefore decreasing the risk of nerve damage^{5,20}.

The most clear disadvantage in clinical routine use of piezosurgery is the longer time required for the osteotomy.

Barone et al¹⁰, comparing the use of piezoelectric device vs. conventional rotative instruments during the maxillary sinus augmentation procedure, showed that the time necessary for the osteotomy and sinus membrane elevation with conventional instruments was 10.2 ± 2.4 minutes, while it was 11.5 ± 3.8 minutes with the piezoelectric device, with no statistically significant differences. These findings were in agreement with the data recorded in the present study, where the piezosurgical procedure took longer to complete than the conventional rotator osteotomy with not statistically significant difference.

Considering the use of patient-centered outcome scales, there has not been published on patients’ perceptions on quality of life and risk factors for severe discomfort after CAOT, moreover it is not possible to refer to other studies.

However, the more rapid return to the baseline OHIP-14 values in the conventional rotary osteotomy technique group observed in our study may be caused by the shorter duration of surgery.

The only comparable study was conducted by Sivolella et al³.

In this study the use of piezoelectric surgery and conventional rotatory osteotomy for mandibular third molar germ extraction was compared.

In their study³, as in the present, the piezosurgical procedure took longer to complete, but the difference was statistically significant, and the pain experienced in the week after the procedure, as recorded by patients on the VAS, showed no statistically significant difference in the progression of pain caused by the 2 treatment types.

Conclusions

The mean duration of fixed orthodontic treatment poses high risks of caries, external root resorption and decreasing patient compliance.

Accelerating orthodontic tooth movement and resulting shortening of treatment duration are therefore topic issues.

Despite of the different techniques described in literature, corticotomy is the only effective and safe one to accelerate orthodontic tooth movement, but few reports are present.

Considering the results of the current study, whatever osteotomy cuts technique was used, piezoelectric surgery or conventional rotatory osteotomy, the subjects which underwent corticotomy-assisted orthodontic treatment (CAOT) showed a functional limitation and physical disability as well as psychological and social aspects of disability and handicap, corresponding to the increase in OHIP-14 scores.

The postoperative deteriorating quality of life of patients treated with corticotomy, should push the clinician to use this technique in limited cases, until more clinical studies will be available to demonstrate its real usefulness.

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