



Effect of Stem Cells and Piezo Corticotomy on Pocket depth and Pain

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Abstract

Aim: In this study we were aiming to determine and evaluate the effect of the stem cells and piezo corticotomy on pocket depth and pain.

Materials and Methods: 22 patients from both genders were selected. The age range of the selected cases in between (15 and 20 years). All patients were examined to fulfill the inclusion criteria. These patients were divided into two groups; control group and intervention group. Split mouth technique was adopted in the intervention group to minimize the variables. In the intervention group one side received piezocorticotomy only, while the other side received piezocorticotomy and stem cells. In control group conventional orthodontic treatment was carried out. To measure the pocket depth; assessment of the pocket depth of the canine before surgery and after complete canine retraction on each side was carried out. To assess pain; Pain was registered on each side (right and left) from day one after surgery and everyday till the end of the week.

Results: pocket depth: as regards upper arch there was a statistically significant difference between the groups. stem cells group showed the statistically significantly lowest mean Results 66 PD. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly higher mean pocket depth. Similarly, with lower arch Post-operatively; there was a statistically significant difference between the groups stem cells group showed the statistically significantly lowest mean pocket depth. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly higher mean pocket depth. Pain: As regards upper arch at day 1 as well as day 2; there was a statistically significant difference between the groups. stem cells group showed the statistically significantly highest median pain score. Piezo group showed statistically significantly lower median score. Control group showed the statistically significantly lowest median pain score. At day 3; there was a statistically significant difference between the groups. stem cells group showed the statistically significantly highest median pain score. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly lower median scores. As regards lower arch at day 1; there was a statistically significant difference between the groups. stem cells group showed the statistically significantly highest median pain score. Piezo group showed statistically significantly lower median score. Control group showed the statistically significantly lowest median pain score. At day 2; there was a statistically significant difference between the groups. stem cells group showed the statistically significantly highest median pain score. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly lower median scores. At day 3; there was no statistically significant difference between the groups.

Conclusion: Stem cells could enhance the periodontium as the pocket depth was decreased after injection. Pain was higher in stem cells group than piezo group in upper and lower arch but could be controlled by paracetamol. Stem cells aspiration from the ramus was performed without any pain or complications under local dental anesthesia.

Keywords: Pocket Depth; Pain; Stem Cells; Piezo Corticotomy; Split Mouth

Introduction

The development of corticotomy assisted orthodontics (CAO) offered solutions to many limitations in the management of orthodontic patients. Over the past several years, corticotomy has become a popular means of increasing the rate of tooth movement. In corticotomy, the cortical layer is cut or perforated to the depth of the medullary bone which is preserved [1].

Reduced treatment time due to corticotomy-assisted orthodontics is extremely beneficial to the patient's periodontal health because less time in fixed appliances reduces the time available for commensally bacterial bio-films to convert into pathogenic microbes and cause periodontal destruction. This is often seen in patients who wear fixed appliances for more than 2 years. Hence, this interdisciplinary approach of corticotomy-assisted orthodontics gives a dual benefit of faster treatment as well as reduced chances of periodontal destruction [2].

In (2012); bone grafting in corticotomy facilitated orthodontics in adults was evaluated from clinical and radiographic points of view. Twenty adult patients were treated in two groups. Both groups were treated by conventional corticotomy technique on the labial cortical bone only, leaving the lingual side intact. The first group was treated with corticotomy only while the second group was treated with corticotomy with bone graft. They Review of literature 12 concluded that corticotomy facilitated orthodontic technique with bone graft resulted in better outcome. The study resulted in a significant reduction in total treatment time, increased alveolar density, reduced incidence of root resorption and periodontal problems [3].

In (2014); a split-mouth design randomized controlled trial to evaluate the efficacy of alveolar corticotomy on orthodontic tooth movement when retracting upper canines compared with conventional technique and to evaluate patients' pain and discomfort levels after corticotomy. A total of 30 patients whose orthodontic treatment required canine retraction were included. The predictor variable was the use of corticotomy to facilitate tooth movement. The velocity of space closure was evaluated as the primary outcome variable by measuring the distance between the canine and first molar on each side of the mouth immediately after corticotomy and at 1, 2, 4, 8, and 12 weeks after corticotomy. The levels of pain and discomfort were evaluated as the secondary outcome variables

using a questionnaire administered 4 times during the first week after corticotomy. The space closure velocity after corticotomy was significantly faster on the experimental side than on the control side (mean = 0.74 mm/week vs. 0.20 mm/week between 1 week after and immediately after corticotomy, respectively; $P < .001$). The pain encountered during eating was high, with 50% and 30% of patients reporting severe pain at 1 and 3 days postoperatively, respectively. No significant differences were detected between the male and female patients regarding the tooth movement velocity on the experimental side. They concluded that alveolar corticotomy increased orthodontic tooth movement and was accompanied by moderate degrees of pain and discomfort [4].

In (2015); an analysis of bone augmentation with corticotomy-facilitated dental expansion was done, in which he concluded that: arch wire expansion after corticotomies resulted in similar amounts of tooth movement, whether grafting was or was not performed. Although tipping was controlled, all of the teeth demonstrated bony dehiscence over both roots, with approximately Review of literature 13 30% less bone loss occurring in the Graft positive than Graft negative group. Corticotomies with bone augmentation was associated with more dense buccal bone than corticotomies alone. After corticotomy-facilitated dental expansion, grafted bone was evident within host bone, with more new bone formation occurring apically than coronally. Soft tissue was not detrimentally affected by corticotomies [5].

In (2016); they studied the effect of buccal corticotomy on accelerating maxillary canine retraction. The sample in this clinical trial study consisted of 15 adult female patients with therapeutic need for extraction of maxillary first premolars and maximum canine retraction. By use of split-mouth design, at the time of premolars extraction, buccal corticotomy was performed around the maxillary first premolar, randomly on one side of maxilla, and the other side was reserved as the control side. Canine retraction was performed by use of frictionless mechanic with simple vertical loop. Every 2 weeks, distance between canines and second premolars was measured until complete space closure. The velocity of space closure was calculated to evaluate the effect of this technique in accelerating orthodontic tooth movement. The rate of canine retraction was significantly higher on the corticotomy side than the control side by an average of 1.8 mm/month versus 1.1 mm/month in the corticotomy side and control side, respectively ($P < 0.001$). Based

on result of this study, corticotomy can accelerates the rate of orthodontic tooth movement about two times faster than conventional orthodontics and it is significant in early stages after surgical procedure. Therefore, buccal corticotomy is a useful adjunct technique for accelerating orthodontic tooth movement [6].

Stem cells are unspecialized cells and have the potential to become one or more specialized cell types. Stem cells have the ability to divide to give rise to both daughter cells and more specialized function cells [7].

Orthodontic tooth movement (OTM) achieved by alveolar bone response to applied pressure and PDL remodeling under various mechanical loading forces. Constriction of the periodontal ligaments causes the initial inflammation in the sites of pressure which lead to focal necrosis and osteoclasts calling from adjacent to marrow spaces. These last are mostly comes from hematopoietic stem cells. Regarding, stem cells may be used in orthodontic tooth movement to aid in acceleration by providing progenitor cells [7,8]. Stem cell therapy has the ability to accelerate alveolar bone regeneration [9].

In (2012); corticotomy and tissue engineering for orthodontics was discussed from historical point of view and so the new way of thinking to open a new gate for treatment. The article explains how to utilize the benefits of both corticotomy facilitated orthodontics combined to tissue engineering which includes the stem cells therapy as a new era in medicine, dentistry and orthodontics [10].

In (2012); corticotomy and Stem Cell therapy have been discussed as a beneficial concept for orthodontists and periodontists. The topic had an overview for Rationale, Hypotheses and Protocol of corticotomy and stem cell therapy. This attempt aimed to enlarge the dental arch basis more speedily, without pain, and with less tissue morbidity than other methods. The incorporation of stem cell therapy is an important element for a wider age of tissue engineering in the twenty first century [9].

Aim of the study

The aim of this study was to determine the effect of stem cells and piezo corticotomy on the pocket depth and pain.

Subjects and Methods

The study was designed as a randomized controlled clinical study. Twenty-two patients were randomly divided into two groups

with eleven patients each. These patients selected from those attending the outpatient clinic, Department of Orthodontics, Faculty of Oral and Dental Medicine for Girls, Al Azhar University (Girls Branch). All procedures were explained for all patients, informed consent was assigned.

Inclusion criteria for this study were; patients in need to extract four first premolars. Full retraction of the maxillary and mandibular canines with moderate anchorage needed as a part of the orthodontic treatment plan. All permanent teeth other than the third molars were present and fully erupted in both arches and good oral hygiene.

The first group; the control group went through conventional dental orthodontic treatment and canine retraction without any surgical procedure.

The second group; the study group employed the split mouth technique; where both right and left canines of the same patient distributed randomly; In one side piezocorticotomy was done distal to the canine using flap technique, while in the other side piezocorticotomy was done distal to the canine using flap technique then a scaffold holding stem cells was added.

Patient Preparation; all subjects included in this study were subjected to the following records: extra-oral photograph, Intra-oral photograph, Impression of upper and lower arches to prepare orthodontic study cast, panoramic radiograph, lateral cephalometric radiograph and probing depth was measured just before surgery.

Operative procedures

In the study group

After extraction of the first premolars, a conservative incision gingivally was done in the position of the canine till second premolar. A single vertical piezoelectric cut was made distal to the canine on the buccal side using tunneling technique, using NSK ultrasonic bone surgery system Variosurg 3 on program 4 at power 150% with NSK SG4 Variosurg tip (Figure 1-a).

In piezocorticotomy side; After extraction and piezocorticotomy; flap incision was gently closed by sutures.

In the study side; Stem cells prepared on the scaffold were adapted distal to the canine and in to the extraction socket and

then scoring of the flap incision was done to allow closure of the socket.

For stem cells extraction

A bone trucker with gauge 25 was inserted on the outer buccal cortex lateral to external oblique ridge of mandibular ramus to reach the mandibular bone marrow. Then the trucker was connected to a syringe with gauge 25 containing 5ml (0.5 heparin and 4.5 saline) to prevent coagulation. This syringe was used to pump out the mandibular bone marrow, during each surgery ~8-10 ml bone marrow were pumped (according to each patient) (Figure 1-b).



Figure 1: a: buccal piezo corticotomy cut. b: point of insertion of the bone trucker. c: isolated bone marrow after centrifugation. d: stem cells added to adsorbable scaffold.

Ficoll separation technique was used to isolate the stem cells. The isolated bone marrow 10ml with heparin and saline 5ml; these 15ml were then divided in two centrifugal tubes and each containing 3ml ficoll then centrifuge was done at speed 3500 for 20 minutes. Each tube after centrifuge had four separate layers; yellow, turbid cloudy layer (stem cells), clear layer and deep red layer (red blood cells) (Figure1-c). The stem cells were isolated and added to the scaffold (Equispon absorbable gelatin sponge) (Figure 1-d).

The scaffold containing stem cells was adapted distal to the canine and into the extraction socket of stem cells side.

Post operative instructions were similar to those following any minor oral surgery. Only panadoland alphinern were prescribed after surgery.

The distal retraction of the right and left canines; was performed using a closed NiTi coil spring. The closed NiTi coil spring delivered 150 gm of force in all groups.

Assessment of the pocket depth of the canine before surgery and after complete canine retraction on each side was carried out

as follows; [26] Probing depth was measured from the free gingival margin to the base of the sulcus using William's graduated periodontal probe. The probe was inserted parallel to the long axis of the tooth using light force of around 0.25 N and recorded to the nearest 0.1 mm.

Pain was registered on each side (right and left) from day one after surgery and everyday till the end of the week. The pain was described through the pain scale using a number from 1 to 10 for each side, where zero was no pain and 10 was severe pain and that was clearly explained to the patient. Each patient was asked to report this daily for one week long after surgical procedure either through phone calls or messages.

Results

Clinically; 22 patients had successful healing and complete canine retraction.

Statistical analysis was done for all collected data using ANOVA test, Kruskal-Wallis test, Friedman's test, Dunn's test. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Pain

Comparison between the three groups

As regards upper arch at day 1 as well as day 2; there was a statistically significant difference between the groups (P -value < 0.001 , Effect size = 0.924) and (P -value < 0.001 , Effect size = 0.846), respectively. Pair-wise comparisons between the groups revealed that stem cells group showed the statistically significantly highest median pain score. Piezo group showed statistically significantly lower median score. Control group showed the statistically significantly lowest median pain score. At day 3; there was a statistically significant difference between the groups (P -value < 0.001 , Effect size = 0.699). Pair-wise comparisons between the groups revealed that stem cells group showed the statistically significantly highest median pain score. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly lower median scores.

As regards lower arch at day 1; there was a statistically significant difference between the groups (P -value < 0.001 , Effect size = 0.830). Pair-wise comparisons between the groups revealed that

stem cells group showed the statistically significantly highest median pain score. Piezo group showed statistically significantly lower median score. Control group showed the statistically significantly lowest median pain score. At day 2; there was a statistically significant difference between the groups (P-value < 0.001, Effect size = 0.731). Pair-wise comparisons between the groups revealed that stem cells group showed the statistically significantly highest median pain score. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly lower median scores. At day 3; there was no statistically significant difference between the groups (P-value = 0.125, Effect size = 0.090).

Changes by time within each group

As regards stem cells and Piezo groups in the upper arch, there was a statistically significant change in pain scores by time (P-value < 0.001, Effect size = 1.000) and (P-value < 0.001, Effect size = 0.781), respectively. Pair-wise comparisons between the time periods revealed that there was a statistically significant decrease in median pain scores at day 2 as well as from day 2 to day 3. Control group showed no pain at day 1, 2 or day 3. As regards stem cells group in the lower arch, there was a statistically significant change in pain scores by time (P-value < 0.001, Effect size = 0.975). Pair-wise comparisons between the time periods revealed that there was a statistically significant decrease in median pain scores at day 2 as well as from day 2 to day 3. As regards Piezo group, there was a statistically significant change in pain scores by time (P-value = 0.008, Effect size = 0.538). Pair-wise comparisons between the time periods revealed that there was a statistically significant decrease in median pain scores at day 2 followed by non-statistically significant change in pain scores from day 2 to day 3. Control group showed no pain at day 1, 2 or day 3.

Pocket Depth (mm)

Comparison between the three groups

As regards upper arch pre-operatively; there was no statistically significant difference between the groups (P-value = 0.375, Effect size = 0.040). Postoperatively, there was a statistically significant difference between the groups (P value = 0.004, Effect size = 0.202). Pair-wise comparisons between the groups revealed that stem cells group showed the statistically significantly lowest mean PD. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly higher

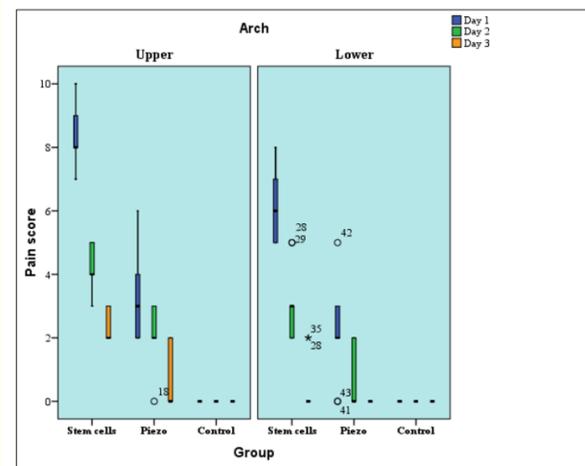


Figure 2: Box plot representing median and range values for pain scores in the three groups (Circles and stars represent outliers).

mean PD. Similarly with lower arch pre-operatively, there was no statistically significant difference between the groups (P-value = 0.206, Effect size = 0.064). Post-operatively; there was a statistically significant difference between the groups (P-value = 0.004, Effect size = 0.202). Pair-wise comparisons between the groups revealed that stem cells group showed the statistically significantly lowest mean PD. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly higher mean PD.

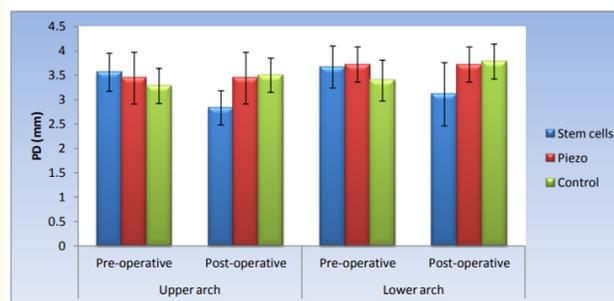


Figure 3: Bar chart representing mean and standard deviation values for Pocket Depth (PD) in the three groups.

Changes by time within each group

As regards stem cells group in the upper arch, there was a statistically significant decrease in PD post-operatively (P-value < 0.001, Effect size = 0.378). While in Piezo and control groups; there was no statistically significant change in PD post-operatively (P-value = 1.000, Effect size = 0.000) and (P-value = 0.103, Effect size = 0.054), respectively. As regards stem cells group in the lower arch, there was a statistically significant decrease in PD post-operatively (P-value < 0.001, Effect size = 0.265). In Piezo, there was no statistically significant change in PD post-operatively (P-value = 1.000, Effect size = 0.000). While in control group; there was a statistically significant increase in PD post-operatively (P-value=0.005, Effect size = 0.150).

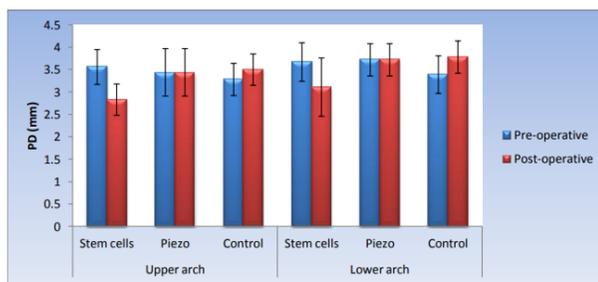


Figure 4: Bar chart representing mean and standard deviation values for Pocket Depth (PD) pre- and post-operatively within each group.

Discussion

Alveolar corticotomies and many other approaches that aim to reduce the time required for orthodontic therapy; these approaches have brought better results but they are not the ultimate solution, newer technologies are always welcomed. Technologies such as stem cell therapy hold a great potential and can bring a revolutionary change [8,12].

Mandibular bone marrow mesenchymal stem cells were used as they are skeletal tissue cells progenitor as they produce bone, cartilage, supporting stroma, and also adipocytes [13]. Mandibular bone marrow mesenchymal stem cells are higher in population and in rate of proliferation when put in comparison to those stem cells

of the long bone marrow mesenchymal tissue [14]. MSCs percentage in population of mononuclear cell achieved and collected from both iliac crest and mandible are similar [15].

In this study; chair side cellular stem cell therapy grafting approach was used that relies on the direct use of a patient derived fresh cellular graft prepared at the chair side using ficoll technique [16]. This approach is relatively clinically convenient for clinicians because it does not require laboratory support so it eliminates laboratory work risks and may result in more predictable regenerative better outcomes [17].

This study was to discover the effect of adding stem cells therapy to piezocorticotomy approach to achieve better periodontium health and to assess the severity of pain during this procedure.

Ethics statement: the study was approved by the Research Ethical Committee of Quality Education Assurance Unit, Al Azhar Faculty of Medicine, Al Azhar University, Nasr City, Cairo Egypt. All subjects received information about the procedure of corticotomy, stem cells therapy and signed the written informed consent form.

This study was performed on 22 adult patients with age range 15-20 years old of both sexes. They were randomly distributed in to two equal groups. In group 1; 11 patients were allocated (4 males and 7 females) with average age 16.6years (SD 2.7), split mouth technique was carried out in this group. While in group 2: 11 patients were allocated (3 males and 8 females) with average age 17.4 years (SD 1.7). The demographic data analysis revealed that; There was no statistically significant difference between mean age values of the two groups. Also, there was no statistically significant difference between genders distribution in the two groups. As regards pain in the upper arch; at day 1 as well as day 2; stem cells group showed the statistically significantly highest median pain score. Piezo group showed statistically significantly lower median score. Control group showed the statistically significantly lowest median pain score. At day 3; stem cells group showed the statistically significantly highest median pain score. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly lower median scores. As regards pain in the lower arch at day 1; stem cells group showed the statistically significantly highest median pain score. Piezo group showed statistically significantly lower median score. Control group showed the statistically significantly lowest median pain score. At day 2;

stem cells group showed the statistically significantly highest median pain score. There was no statistically significant difference between Piezo and control groups; both showed statistically significantly lower median scores. At day 3; there was no statistically significant difference between the groups. Piezocorticotomy was found in previous studies painful than conventional orthodontic treatment and could cause swelling [4,18-20]. Although other studies stated that it was not painful and had no complications [21]. Stem cells therapy caused more pain this may be due to the higher cellular activity that appeared in the faster and better healing in this group as in platelet rich plasma studies where pain was reported [22]. In this study stem cells therapy site showed pain and, in some cases, swelling too but the patients did not need to take any medication other than Paracetamol and Alphintern. As regards pocket depth in stem cells group in the upper arch, there was a statistically significant decrease in PD post-operatively. While in Piezo and control groups; there was no statistically significant change in PD post-operatively. As regards pocket depth in stem cells group in the lower arch, there was a statistically significant decrease in PD post-operatively. In Piezo; there was no statistically significant change in PD post-operatively. While in control group; there was a statistically significant increase in PD post-operatively. In previous piezocorticotomy studies; no periodontal damage was found [5,23-27]. In other studies periodontal affection was reported [28,29]. Adding bone graft to corticotomy was able to enhance the periodontal condition. (30) While stem therapy was used for periodontal regeneration [31-33].

Conclusions

- Stem cells could enhance the periodontium as the pocket depth was decreased after injection.
- Pain was higher in stem cells group than piezo group in upper and lower arch but could be controlled by paracetamol.
- Stem cells aspiration from the ramus was performed without any pain or complications under local dental anesthesia.

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