



Comparison of the Effectiveness of Dexamethasone Injection into Two Different Sites in Preventing the Postoperative Complications after Mandibular Third Molar Surgery: A Randomized Clinical Trial

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Inflammation occurring after the surgical removal of impacted lower third molars can cause complications such as pain and swelling. The aim of this study was to compare the effectiveness of dexamethasone injection into the medial pterygoid and gluteal muscles in preventing postoperative complications after surgical removal of bony impacted mandibular third molars.

Study Design: Parallel randomized clinical trial.

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Place and Duration of Study: Oral Surgery Department of the Torabinejad Dental Research Center, between April 2013 and January 2014.

Methodology: This trial included 77 participants aged between 18 and 35 years [mean age (mean \pm standard deviation), 25.04 \pm 4.33 years] requiring surgical removal of a single bony impacted mandibular third molar under local anesthesia. Participants were randomly assigned to 3 groups based on systematic random. Postoperative pain, swelling, patients' general satisfaction, and changes in daily life function were evaluated. These factors were first analyzed by the Kruskal–Wallis and ANOVA tests, followed by the Mann–Whitney test.

Results: The two dexamethasone groups had significantly less postoperative pain, swelling, and change in appearance at 48 h after the surgery compared with the DF group.

Conclusion: With the caution of a small sample size, the results of this study indicate that near the surgical field preoperative injection of dexamethasone in the medial pterygoid muscle can control postoperative pain, swelling, and changes in appearance as efficiently as the same in the gluteus muscle.

Keywords: Dexamethasone injection; third molar; impacted tooth; postoperative complications.

1. INTRODUCTION

The surgical removal of impacted lower third molars is the most frequent intervention in oral surgery [1]. This surgery causes trauma to soft and hard tissues, and the body's physiologic response to such trauma is inflammation and pain [2-5]. Although inflammatory processes are necessary for healing, excessive inflammation can cause complications such as pain, swelling, and trismus [6-8].

These expected sequels influence the patients' quality of life in the immediate postoperative period [9-13]. Patients who experience pain, swelling, and trismus after the surgery experience a reduced quality of life three times more frequently than asymptomatic patients [14]; Therefore, a treatment to control the postoperative inflammation leads to patient comfort.

A variety of treatments have been suggested in previous clinical studies to reduce postoperative complications, including antiseptic mouthwashes [15], different flap designing [16], prophylactic antibiotics [17-18], sutureless wound closure [19], muscle relaxants [20], cold therapy [21], corticosteroids [22-30], and nonsteroidal anti-inflammatory drugs [31].

Among these, corticosteroids have been widely used in oral surgery [29-30,32-35]. They have an inhibitory effect on the enzyme phospholipase A2, which reduces the release of arachidonic acid at the site of inflammation. As a result, production of vasoactive substances such as prostaglandins and leukotrienes is suppressed,

leading to reduced fluid transudation and consequent edema [7,36-37].

Prolonged use of corticosteroids can delay the healing process and increase susceptibility to infection; however brief treatments with the doses typically used in oral surgery do not usually cause any clinically significant adverse effects [7,37].

The most common forms of corticosteroids used in dentoalveolar surgery include dexamethasone, methylprednisolone, and betamethasone sodium phosphate. Among these, dexamethasone is most recommended because of its long duration of action and high potency [6].

Results of earlier studies have shown that there were no significant differences in the alleviation of trismus, facial swelling, and pain between different steroid dosages [38-39]. Due to the limited efficiency of postoperative corticosteroid therapy, preoperative corticosteroid administration modes such as intramuscular, intravenous, and submucosal injections are recommended more than other administration modes [6,40].

Grossi et al. [38] reported that injection of low-dose dexamethasone into the surgical site achieves a higher effective drug concentration at the site of injury without the loss caused by distribution to other compartments. In addition, injecting the corticosteroids in an already anesthetized area is convenient for both the surgeon and the patient [38], while gluteal injections are more demanding in terms of time and equipment [32,37].

It should be noted that corticosteroids may not always be necessary for wisdom teeth removal and are indicated only in cases in which there are technical difficulties in accessing the bony impacted teeth [41-42].

Current recommendations for corticosteroid therapy in dentistry are empiric. Well-designed clinical studies to further evaluate protocols designed to decrease corticosteroid side effects and increase postoperative patient satisfaction are warranted. This study aimed to compare the effect of dexamethasone injection into the medial pterygoid for the first time and gluteal muscles, regarding postoperative pain, swelling, patients' general satisfaction, and changes in daily life function after surgical removal of bony impacted mandibular third molars.

2. MATERIALS AND METHODS

This parallel randomized clinical trial included 90 patients aged between 18 and 35 years, and requiring surgical removal of a single bony impacted mandibular third molar under local anesthesia. These patients were treated at the Oral Surgery Department of the Torabinejad Dental Research Center between April 2013 and January 2014. The study protocol was approved by Isfahan Regional Bioethics Committee.

The inclusion criteria were diagnosis of bony impacted mandibular third molars without pericoronitis or infection at the time of operation. The exclusion criteria were as follows: concurrent pregnancy, uncontrolled systemic diseases, history of allergy to the drugs used in the study, and recent use of anti-inflammatory drugs or antibiotics. All patients provided written informed consent before inclusion in the study.

Criteria for exclusion of patients after entering the study were as follows: the use of extra anti-inflammatory drugs or antibiotics during observation period, refusal of continuing the present study, impossibility of follow-up, abnormal healing process, and extraction of teeth without osteotomy or teeth requiring severe osteotomies. As the anatomical features of right side is as same as the left side and considering high ability of the surgeons to perform the surgery equally at both sides, left side or right side was not considered in randomization.

Systematic random sampling was done as follows: Patients were examined and verified by an expert surgeon based on panoramic

radiography. Those who provided written informed consent were randomly divided into three intervention groups. Ninety patients were arranged in a predetermined list based on time of entering the study, and each participant was assigned a number.

Patients were randomly assigned to three groups of 30 participants. The patients' assignment to the groups was based on systematic random numbering, i.e, number "1" was assigned to the first group, number "2" was assigned to the second group, and number "3" to the third group, and numbers with tertiary distance were assigned to the same group. Group "1" or dexamethasone free group (DF) received no drug; the second group (DIG) received 8 mg of dexamethasone injected into the gluteal muscle after the surgery, while the third group (DIM) received 8 mg of dexamethasone injected into the medial pterygoid muscle before the surgery.

2.1 Operative Procedures

The two surgeons and the student involved with the patients were blinded to the groups, and only one student who had injected the corticosteroid and anesthesia was aware of the group allocations. However, as the patients in the second group were to receive the corticosteroid injection in gluteal muscle, they were aware of the receiving drug.

All the operations were carried out by two postgraduate residents in oral and maxillofacial surgery. Anesthesia was performed using standard inferior alveolar nerve block and long buccal nerve block [43] using a solution of 2% lidocaine with 1:100,000 adrenaline (Xylocaine; Darou Pakhsh, Tehran, Iran).

Patients in group "3" received 8 mg dexamethasone (Dexamethazone; Iran hormone, Iran) in the medial pterygoid muscle using a 24-gauge needle just after signs of anesthesia were noted in the patient. Then, surgical access was established through a standard triangular mucoperiosteal flap from the external oblique ridge, and a releasing incision was made at the mesial aspect of the second molar using blade number 15 (Surgical blade; Isomed, China) [44]. After elevating the flap, bone was removed around the tooth with a round bur under continuous irrigation with sterile saline solution. If necessary, sectioning of crown and roots was performed with a fissure bur. After extraction, the socket was irrigated with

abundant sterile saline solution, and the flap was sutured with 3 to 5 interrupted 3.0 silk sutures (Braided silk; Supa, Tehran, Iran) [45]. A small gauze pack was then applied to the surgical site, and the patient was requested to hold it down firmly for about 1 h.

The following postoperative medications according to protocol of the department was prescribed to all patients: amoxicillin 500 mg every 8 h for 7 days and paracetamol 500 mg every 4 to 8 h depending on the severity of pain (patients were requested to record the number of tablets taken). In addition, a 0.2%-chlorhexidine mouth rinse (Chlorhexidin; Epimax, Emad, Esfahan, Iran) was prescribed twice daily. Prescription the same medications for all patients minimize confounding bias of probable drug abuse on the result. The patients were given the usual postoperative instructions, i.e., a cold semi-liquid diet for the first day and re-establishing normal oral hygiene routine the day after surgery.

2.2 Assessment and Follow-up

2.2.1 Pain

Postoperative pain was evaluated using a 10 cm-visual analog scale (VAS) [19,26,33,46], ranging from 0 for “no pain” to 10 for “the worst/most unbearable pain possible” and the number of analgesic tablets required [32,35,39]. The survey was conducted by telephonic interview 48 h after the surgery and on the seventh day of follow up.

2.2.2 Swelling

Patients entered the degree of swelling on the visual analog scale ranging from 0 to 5; the patients were informed about the values and corresponding clinical situations for each score on the scale [46]. The survey was conducted by telephonic interview 48 h after the surgery and on the seventh day of follow up.

2.2.3 General patient satisfaction

The patients were asked to score their satisfaction from 0 to 10, where 0 represents no satisfaction and 10 representing complete satisfaction of the surgery. Total satisfaction of the surgery was recorded by telephonic interview 48 h after the surgery and on the seventh day of follow-up.

2.2.4 Changes in daily life

To measure the effect of the surgery on the quality of life, a questionnaire was completed by the patients on day 4 and 7 after surgery by telephonic interview [26].

The questionnaire consisted of 14 questions pertaining to five different domains addressing social isolation, eating ability, speaking ability, sleep impairment, and physical appearance.

The patients were instructed to answer all the 14 questions and score the items on a 4-point scale from “never” to “very much” about their experience regarding the surgery. The questionnaire also included questions about the duration of each 5-domain effect on the quality of life to be recorded by the patients on day 7.

After translating the questionnaire to Persian, content validity was verified by two experienced surgeons, and face validity was examined at the beginning of the study.

Based on similar previous studies [37], 25 patients are required for each method to achieve 80% test power to identify significant differences in median values of the scored swelling scales at the 5% level ($d = 0.65$); however, with three comparison groups, the Bonferroni adjustment was applied and the difference was considered statistically significant [$p < 0.0167$ ($0.05/3 = 0.0167$)]. The alpha level was verified in all tests at 0.05. Due to the possibility of loss of participants during the study, the number of subjects in each group was increased to 30.

Data analysis was performed using SPSS version 16.0 statistical Software (SPSS, Inc., Chicago, IL). Data were first compared using the Kruskal–Wallis and analysis of variance ANOVA tests. Then, the Mann–Whitney test was used to compare the paired results for the different groups.

3. RESULTS

Fig. 1 shows the diagram demonstrating the patients participating in the study. At the beginning of the study, 126 patients were assessed for eligibility criteria. Of these, 25 patients (29%) were excluded as they did not meet the inclusion criteria, and 11 patients declined to participate in the study. Ninety participants were randomly assigned into 3 groups with 30 participants in each intervention

group. No statistically significant differences regarding gender and age were present (Table 1).

In the DF group, 6 patients were excluded because of abscess formation (n = 1), failure to follow-up (n = 1), and use of additional doses of drugs (n = 4). In the DIG group, 3 patients were excluded because of the use of additional doses of drugs (n = 1), dry socket (n=1), and failure to follow-up (n = 1). In the DIM group, 4 patients were excluded because of using additional doses of drugs (n = 2) and failure to follow-up (n = 2).

Kruskal–Wallis analysis was used to compare questionnaire scores, pain, and swelling. In addition, analysis of variance (ANOVA) was used to compare the number of consumed analgesic tablets and the number of days that daily life function was affected (Table 1). Then, the indices with $p \leq 0.1$ were examined by the Mann–Whitney test (Table 2). The median values of the identified items from Table 2 and mean values and standard deviations only for significant items with the same median values are shown in Table 3.

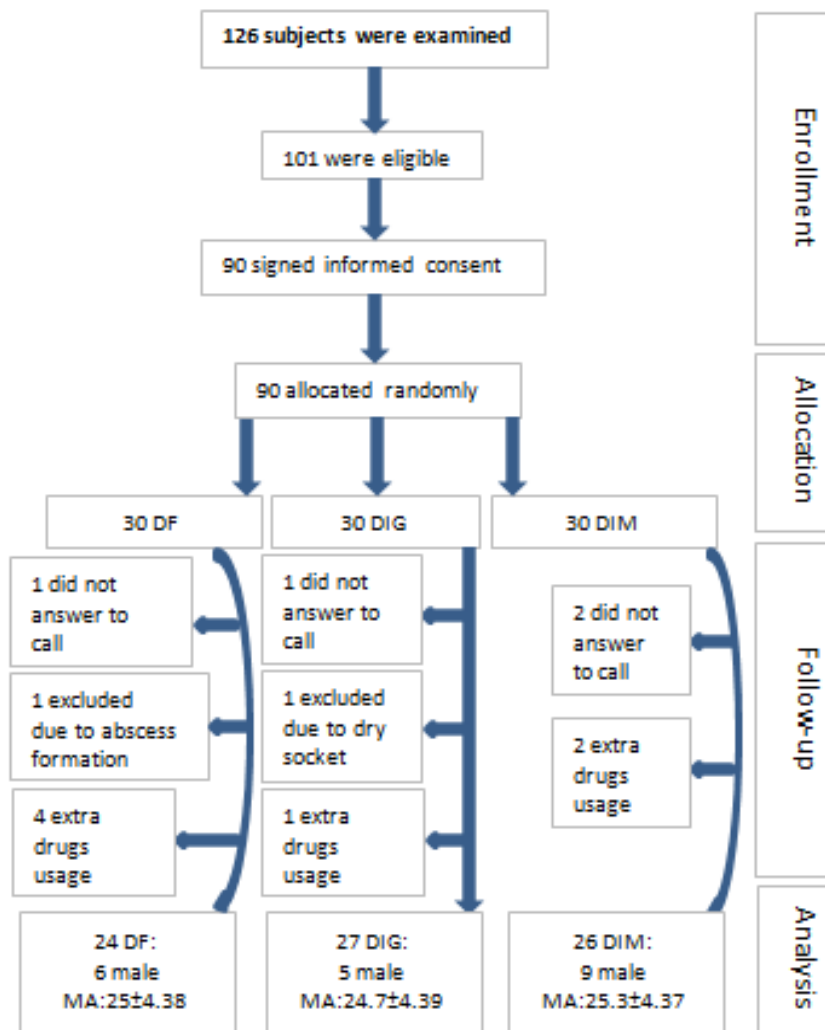


Fig. 1. Diagram of trial phases

DF: Dexamethasone free; DIG: Dexamethasone injected into the gluteal; and DIM: Dexamethasone injected into the medial pterygoid

Table 1. P values in comparing the items between each 3 groups

| Compared items | P values |
|---|----------------------|
| Gender | 0.41 ^k |
| Age | 0.89 ^a |
| Consumed analgesics tablets within 48 h | 0.36 ^a |
| Pain VAS at 48 h | 0.001 ^k # |
| Swelling at 48 h | 0.006 ^k # |
| General patient satisfaction within 48 h | 0.09 ^k # |
| Consumed analgesics tablets at 48 h to 1 week | 0.53 ^a |
| Pain VAS at 1 week | 0.17 ^k |
| Swelling at 1 week | 0.13 ^k |
| General patient satisfaction within 1 week | 0.27 ^k |
| Consumed analgesics tablets within 1 week | 0.50 ^a |
| Social activities | 0.90 ^k |
| Hobbies interests | 0.32 ^k |
| Normal diet | 0.31 ^k |
| Taste of food | 0.48 ^k |
| Chew foods | 0.05 ^k # |
| Swallow foods | 0.18 ^k |
| Open mouth | 0.006 ^k # |
| Mouth smell | 0.03 ^k # |
| Voice | 0.91 ^k |
| Talk | 0.17 ^k |
| Others understand speech | 0.20 ^k |
| Sleep problems | 0.46 ^k |
| Dizziness | 0.43 ^k |
| Changed appearance | 0.001 ^k # |
| Social isolation | 0.18 ^a |
| Eating | 0.81 ^a |
| Speech | 0.41 ^a |
| Sleep | 0.72 ^a |
| Appearance | 0.10 ^a |

#: Factors with $p < 0.1$ for analysis in the next step (Table 2)

k: Kruskal-wallis; a: Analysis of variance (ANOVA)

The two dexamethasone groups had significantly less pain and swelling 48 h after the surgery compared with the DF group. The questionnaire

item “changes in mouth opening” was scored significantly less in the DIM group than in the DF group. Moreover, “change in appearance” was significantly lower in both the DIG and DIM groups than in the DF group; however, no significant difference was observed between the dexamethasone groups.

Table 2. P-values from the Mann-Whitney U test

| Items | DF vs. DIG | DF vs. DIM | DIG vs. DIM |
|--|------------|------------|-------------|
| Pain VAS at 48 h | 0.002* | 0.001* | 0.89 |
| Swelling at 48 h | 0.013* | 0.003* | 0.43 |
| General patient satisfaction within 48 h | 0.91 | 0.03 | 0.10 |
| Chew foods | 0.08 | 0.02 | 0.46 |
| Mouth opening | 0.15 | 0.002* | 0.06 |
| Mouth smell | 0.02 | 0.02 | 0.99 |
| Changed appearance | 0.002* | 0.001* | 0.39 |

*: Significant at $p < 0.0167$.

DF: Dexamethasone free

DIG: Dexamethasone injected into the gluteus

DIM: Dexamethasone injected into the medial pterygoid

4. DISCUSSION

The null hypothesis of our study was that there would be no differences in pain, swelling, patients’ general satisfaction, and changes in daily life function between groups receiving no dexamethasone, intragluteal dexamethasone, and intra-medial pterygoid dexamethasone; this hypothesis was rejected.

Any injury, including surgery, causes inflammation in the affected area. Inflammation is the body’s defense mechanism to tissue damage, although it causes discomfort. Edema, trismus, and pain can reduce the patients’ quality of life, and studies suggest the use of corticosteroids as a pharmacologic solution for reducing adverse effects following surgery [6,25].

Table 3. Median of significant factors

| Items | DF | IG | IM |
|--------------------|--------------------|------------------|--------------------|
| Pain VAS at 48 h | 6 | 4 | 3 |
| Swelling at 48 h | 2 | 2 | 1 |
| | (mean±SD:2.4±1.06) | (mean±SD:2±1.09) | (mean±SD:1.8±0.98) |
| Open mouth | 3 | 2 | 2 |
| Changed appearance | 3 | 2 | 1 |

DF: Dexamethasone free

DIG: Dexamethasone injected into the gluteus

DIM: Dexamethasone injected into the medial pterygoid

A meta-analysis conducted by Dan et al. [24] showed that corticosteroid administration prior to surgery resulted in reduced pain and swelling with no high risk of infection and with a minimum risk of other adverse effects. Markiewicz et al. [37] concluded in another meta-analysis that perioperative administration of corticosteroids resulted in mild to moderate reduction in postoperative inflammatory signs and symptoms. Specifically, patients given corticosteroids showed significantly less postoperative swelling and trismus than controls, both at 1–3 days after surgery and 4–7 days after surgery. Moreover, the pain reduction was significantly greater in the corticosteroid group than in the control group for the first few days after surgery, but not during the late postoperative period.

In this study, dexamethasone was selected due to its nearly pure glucocorticoid effects, virtually no mineralocorticoid effects, and the least adverse effects on leukocyte chemotaxis. Dexamethasone has a longer duration of action than other corticosteroids such as methylprednisolone and is considered more potent [38].

Previous studies recommend that a dose with maximum effectiveness and minimum adverse effects should be selected [6]. Studies on intramuscular administration of different doses of dexamethasone have suggested that this route of administration can be effective if a single dose is given either preoperatively or postoperatively [34], and that 8 mg dexamethasone promoted a greater reduction of pain and swelling than 4 mg of dexamethasone [2]. Therefore in this study, 8 mg dexamethasone was injected for both DIM and DIG groups.

Only a few studies have examined the effectiveness of corticosteroid injections near the site of surgery in preventing postoperative complications [30,33,38]. This technique has not been widely discussed in the literature due to the scarcity of studies describing it and the lack of data about the advantages of this technique compared with systemic administration of corticosteroids. In addition to the mode of corticosteroid administration, the adjacency to the trauma site is an influential factor [22]. Injection of dexamethasone in the medial pterygoid muscle is a surgically convenient technique as it requires no additional equipment, is similar to inferior alveolar nerve block, and is more convenient for the patient since the injection is placed close to an already

anesthetized area. Other advantages with this technique include better absorption in the thin lingual cortex of the mandibular ramus area compared with the thick buccal cortex and minimum gastrointestinal adverse effects compared with oral administration.

Intramuscular administration of corticosteroids provides excellent and immediate plasma drug concentrations and extended anti-inflammatory action with a single pre- or postoperative dose [34]. While a single preoperative dose provides almost immediate benefit in terms of pain, swelling, and trismus, supplemental doses are usually needed, orally or intramuscularly, for optimum clinical effectiveness [34]. The intramuscular route has a slower onset of action than the intravenous, and the rate of absorption is highly dependent on the rate of blood flow to the site of injection. However, the onset of action is faster than the oral route [7].

To the best of our knowledge, this is the first study to compare the sites of injection in relation to the surgical field with the type and dose of injected drug and route of injection being similar between the groups.

Both dexamethasone groups had significantly less pain and swelling 48 h after surgery compared to patients not receiving corticosteroids.

Studies on the influence of corticosteroids in reducing pain, swelling, and trismus have shown different results, which might be due to variations in drugs, doses, or routes of administration, as well as differences in measurement methods.

Mico-Llorens et al. [28] and Vegas-Bustamante et al. [33] reported superior outcomes with intramuscular administration of 40 mg methylprednisolone when the injection site was closer to the surgical field in the gluteus and masseter muscle, respectively. Vegas-Bustamante [33] reported a reduction in pain for 3 days after surgery and a reduction in swelling and trismus up to 7 days after surgery, while Mico-Llorens et al. [28] reported that the improvements remained significant for only 48 h.

There is a consensus on the role of corticosteroids in reducing swelling among previous studies [30,35], yet, the effect of corticosteroids on pain reduction is controversial [23,25,27]. Vegas-Bustamante [33] found a reduction in pain not only a few hours after

surgery but also for 3 days after surgery following administration of methylprednisolone in the masseter muscle; these results are similar to the present study. Grossi et al. [38] reported no significant reduction in pain after injection of 4 and 8 mg dexamethasone, which could be explained by the fact that in their study, the assessment of pain was performed using the number of analgesics required only.

Pederson [9] has reported that administration of 4 mg dexamethasone in the masseter muscle preoperatively resulted in a 50% reduction in trismus and swelling, but contrary to our results, no significant reduction in pain was observed, which could be due to a lower dose of injected corticosteroid.

“Change in appearance” scores in both dexamethasone groups were significantly lower than in the control group in the first 4 days after surgery, which can be attributed to differences between the group scores regarding the rate of swelling.

Differences in responses between the two dexamethasone groups could be observed; however, these differences were not statistically significant. This could be explained by the small sample size of this study and the subjective assessment of the variables.

“Changes in mouth opening” was significantly lower in the DIM group than in the DF group. Corticosteroids do not have a direct role in muscle contraction, and trismus is mainly a consequence of edema due to fluid accumulation within the muscles of mastication [30]. The greater concentration of dexamethasone achieved immediately at the site of tissue injury might explain this finding based on painless pre operative injection, proximity to pterygoid venous plexus, and high blood flow rate.

Complications after the surgery and inflammatory tissue response are influenced by various factors such as the difficulty of the surgical procedure performed [3], age of the patient [3,5,29], gender of the patient [3,29], and experience of the surgeon [29].

The level of complexity of the surgery is related to the angulation of the impacted tooth (Winter classification), relationship of the tooth to the ramus (class 1, 2, 3 in Pell and Gregory classification), and relative depth of impaction

(class A, B, C in Pell and Gregory classification) [43]. Although many studies assess difficulty of treatment according to the Pell and Gregory classification, the reliability of this method has been questioned for determining the severity and complexity of third molar surgeries, because classification of non-vertical teeth is problematic; however, a large percentage of impactions are not vertical [42]. In this study, panoramic radiography of all patients was evaluated by an experienced surgeon and only bony impacted teeth with average difficulty of surgical removal were enrolled. In addition, cases that were determined to be more complicated than others based on the surgeon’s opinion after the surgery were excluded from the study.

The degree of pain experienced and the amount of rescue analgesics required are influenced by many factors, such as the patient’s age, previous experience of pain, pain threshold, and drug tolerance [5,7]. However, controversies exist regarding the effect of corticosteroids on pain reduction [23,25,27]. The number of rescue analgesic tablets consumed by the patients were evaluated for the control of possible confounding factors which can diminish patient’s response to pain, swelling, and trismus that there was no significant difference between the groups [23].

The current study has two major limitations. First, only 77 participants were included. Second, the variables were patient-reported subjective values, especially “maximum mouth opening”. However, according to previous studies which assessed patients’ condition subjectively, subjective assessments can be equally reliable as objective measurements [26]. Another limitation was lack of blinding in all three groups and placebo injection in the control group due to ethical consideration. Bias was minimized by random allocation of patients to treatment groups and by using non-parametric analysis for less significant items probability. Furthermore, to justify the angulations, size and shape of impacted teeth, and left side or right side variations the surgery hardness was determined by one expert surgeon for all the study population and random sampling was performed in predetermined list.

Further studies on the alleviating effects of dexamethasone injection in the medial pterygoid muscle after designing and providing the corticosteroid’s carpool for routine use by dental syringe on general patient satisfaction should be conducted. Another suggestion for further

studies is evaluation of the long-term healing process after usage of both corticosteroid and non-corticosteroid methods.

5. CONCLUSIONS

The results of the present study indicate that the effect of injection of dexamethasone in the medial pterygoid muscle in preventing postoperative pain, swelling, and changes in appearance is comparable to that of dexamethasone injected into the gluteus muscle. This technique provides a less acquired equipment and time technique, painless solution for relieving pain and discomfort associated with surgical extraction of impacted lower third molars.

ETHICAL APPROVAL AND REGISTRATION

This trial was registered in ClinicalTrials.gov as "NCT01896427". The ethical approval was granted by Isfahan Regional Bioethics Committee (292037).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Shepherd JP, Brickley M. Surgical removal of third molars. *BMJ*. 1994;309(6955): 620-1.
2. Laureano Filho JR, Maurette PE, Allais M, Cotinho M, Fernandes C. Clinical comparative study of the effectiveness of two dosages of dexamethasone to control postoperative swelling, trismus and pain after the surgical extraction of mandibular impacted third molars. *CEP*. 2008;54753:220.
3. Yuasa H, Sugiura M. Clinical postoperative findings after removal of impacted mandibular third molars: Prediction of postoperative facial swelling and pain based on preoperative variables. *British Journal of Oral and Maxillofacial Surgery*. 2004;42(3):209-14.
4. Bamgbose BO, Akinwande JA, Adeyemo WL, Ladeinde AL, Arotiba GT, Ogunlewe MO. Effects of co-administered dexamethasone and diclofenac potassium on pain, swelling and trismus following third molar surgery. *Head Face Med*. 2005;1(11):1-11.
5. Lyons CJ, Bruce RA, Frederickson GC, Small GS. Age of patients and morbidity associated with mandibular third molar surgery. *The Journal of the American Dental Association*. 1980;101(2):240-5.
6. Alexander RE, Thronson RR. A review of perioperative corticosteroid use in dentoalveolar surgery. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 2000;90(4):406-15.
7. Kim K, Brar P, Jakubowski J, Kaltman S, Lopez E. The use of corticosteroids and nonsteroidal antiinflammatory medication for the management of pain and inflammation after third molar surgery: A review of the literature. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 2009;107(5):630-40.
8. Carriches CL, González J, Rodríguez MD. The use of methylprednisolone versus diclofenac in the treatment of inflammation and trismus after surgical removal of lower third molars. *Med Oral Patol Oral Cir Bucal*. 2006;11:440-5.
9. Pedersen A. Decadronphosphate® in the relief of complaints after third molar surgery: A double-blind, controlled trial with bilateral oral surgery. *International Journal of Oral Surgery*. 1985;14(3):235-40.
10. Savin J, Ogden G. Third molar surgery—a preliminary report on aspects affecting quality of life in the early postoperative period. *British Journal of Oral and Maxillofacial Surgery*. 1997;35(4):246-53.
11. McGrath C, Comfort M, Lo E, Luo Y. Changes in life quality following third molar surgery—the immediate postoperative period. *British Dental Journal*. 2003; 194(5):265-8.
12. Colorado-Bonnin M, Valmaseda-Castellón E, Berini-Aytés L, Gay-Escoda C. Quality of life following lower third molar removal. *International Journal of Oral and Maxillofacial Surgery*. 2006;35(4):343-7.
13. Deepti C, Rehan H, Mehra P. Changes in quality of life after surgical removal of

- impacted mandibular third molar teeth. *Journal of maxillofacial and oral surgery*. 2009;8(3):257-60.
14. Slade GD, Foy SP, Shugars DA, Phillips C, White RP. The impact of third molar symptoms, pain, and swelling on oral health-related quality of life. *Journal of Oral and Maxillofacial Surgery*. 2004; 62(9):1118-24.
 15. Larsen PE. The effect of a chlorhexidine rinse on the incidence of alveolar osteitis following the surgical removal of impacted mandibular third molars. *Journal of Oral and Maxillofacial Surgery*. 1991;49(9): 932-7.
 16. Sandhu A, Sandhu S, Kaur T. Comparison of two different flap designs in the surgical removal of bilateral impacted mandibular third molars. *International Journal of Oral and Maxillofacial Surgery*. 2010;39(11): 1091-6.
 17. Lee J, Do H, Lim J, Jang H, Rim J, Kwon J, et al. Correlation of antibiotic prophylaxis and difficulty of extraction with postoperative inflammatory complications in the lower third molar surgery. *British Journal of Oral and Maxillofacial Surgery*. 2014;52(1):54-7.
 18. Siddiqi A, Morkel J, Zafar S. Antibiotic prophylaxis in third molar surgery: A randomized double-blind placebo-controlled clinical trial using split-mouth technique. *International Journal of Oral and Maxillofacial Surgery*. 2010;39(2): 107-14.
 19. Hashemi HM, Beshkar M, Aghajani R. The effect of sutureless wound closure on postoperative pain and swelling after impacted mandibular third molar surgery. *British Journal of Oral and Maxillofacial Surgery*. 2012;50(3):256-8.
 20. Kirmeier R, Truschnegg A, Payer M, Acham S, Schulz K, Jakse N. Evaluation of a muscle relaxant on sequelae of third molar surgery: A pilot study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 2007; 104(3):e8-e14.
 21. Zandi M, Amini P, Keshavarz A. Effectiveness of cold therapy in reducing pain, trismus, and oedema after impacted mandibular third molar surgery: A randomized, self-controlled, observer-blind, split-mouth clinical trial. *International Journal of Oral and Maxillofacial Surgery*; 2015.
 22. Herrera-Briones FJ, Sánchez EP, Botella CR, Capilla MV. Update on the use of corticosteroids in third molar surgery: systematic review of the literature. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*. 2013;116(5): e342-e51.
 23. Alcantara C, Falci S, Oliveira-Ferreira F, Santos C, Pinheiro M. Pre-emptive effect of dexamethasone and methylprednisolone on pain, swelling, and trismus after third molar surgery: A split-mouth randomized triple-blind clinical trial. *International Journal of Oral and Maxillofacial Surgery*. 2014;43(1):93-8.
 24. Dan AE, Thygesen TH, Pinholt EM. Corticosteroid administration in oral and orthognathic surgery: A systematic review of the literature and meta-analysis. *Journal of Oral and Maxillofacial Surgery*. 2010;68(9):2207-20.
 25. Gersema L, Baker K. Use of corticosteroids in oral surgery. *Journal of Oral and Maxillofacial Surgery*. 1992; 50(3):270-7.
 26. Majid OW. Submucosal dexamethasone injection improves quality of life measures after third molar surgery: A comparative study. *Journal of Oral and Maxillofacial Surgery*. 2011;69(9):2289-97.
 27. Esen E, Taşar F, Akhan O. Determination of the anti-inflammatory effects of methylprednisolone on the sequelae of third molar surgery. *Journal of Oral and Maxillofacial Surgery*. 1999;57(10):1201-6.
 28. Mico-Llorens J, Satorres-Nieto M, Gargallo-Albiol J, Arnabat-Dominguez J, Berini-Aytés L, Gay-Escoda C. Efficacy of methylprednisolone in controlling complications after impacted lower third molar surgical extraction. *European Journal of Clinical Pharmacology*. 2006; 62(9):693-8.
 29. Capuzzi P, Montebugnoli L, Vaccaro MA. Extraction of impacted third molars: A longitudinal prospective study on factors that affect postoperative recovery. *Oral Surgery, Oral Medicine, Oral Pathology*. 1994;77(4):341-3.
 30. Graziani F, D'aiuto F, Arduino P, Tonelli M, Gabriele M. Perioperative dexamethasone reduces post-surgical sequelae of wisdom tooth removal. A split-mouth randomized double-masked clinical trial. *International Journal of Oral and Maxillofacial Surgery*. 2006;35(3):241-6.

31. Bailey B, Zaki G, Rotman H, Woodward R. A double-blind comparative study of soluble aspirin and diclofenac dispersible in the control of postextraction pain after removal of impacted third molars. *International Journal of Oral and Maxillofacial Surgery*. 1993;22(4):238-41.
32. Klongnoi B, Kaewpradub P, Boonsiriseth K, Wongsirichat N. Effect of single dose preoperative intramuscular dexamethasone injection on lower impacted third molar surgery. *International Journal of Oral and Maxillofacial Surgery*. 2012;41(3):376-9.
33. Vegas-Bustamante E, Micó-Llorens J, Gargallo-Albiol J, Satorres-Nieto M, Berini-Aytés L, Gay-Escoda C. Efficacy of methylprednisolone injected into the masseter muscle following the surgical extraction of impacted lower third molars. *International Journal of Oral and Maxillofacial Surgery*. 2008;37(3):260-3.
34. Montgomery MT, Hogg JP, Roberts DL, Redding SW. The use of glucocorticosteroids to lessen the inflammatory sequelae following third molar surgery. *Journal of Oral and Maxillofacial Surgery*. 1990;48(2):179-87.
35. Majid OW, Mahmood WK. Effect of submucosal and intramuscular dexamethasone on postoperative sequelae after third molar surgery: comparative study. *British Journal of Oral and Maxillofacial Surgery*. 2011;49(8):647-52.
36. Hirschmann J. Some principles of systemic glucocorticoid therapy. *Clinical and Experimental Dermatology*. 1986; 11(1):27-33.
37. Markiewicz MR, Brady MF, Ding EL, Dodson TB. Corticosteroids reduce postoperative morbidity after third molar surgery: A systematic review and meta-analysis. *Journal of Oral and Maxillofacial Surgery*. 2008;66(9):1881-94.
38. Grossi GB, Maiorana C, Garramone RA, Borgonovo A, Beretta M, Farronato D, et al. Effect of submucosal injection of dexamethasone on postoperative discomfort after third molar surgery: A prospective study. *Journal of Oral and Maxillofacial Surgery*. 2007;65(11):2218-26.
39. Üstün Y, Erdoğan Ö, Esen E, Karsli ED. Comparison of the effects of 2 doses of methylprednisolone on pain, swelling, and trismus after third molar surgery. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 2003;96(5):535-9.
40. Messer EJ, Keller JJ. The use of intraoral dexamethasone after extraction of mandibular third molars. *Oral Surgery, Oral Medicine, Oral Pathology*. 1975; 40(5):594-8.
41. Mercier P, Precious D. Risks and benefits of removal of impacted third molars: a critical review of the literature. *International Journal of Oral and Maxillofacial Surgery*. 1992;21(1):17-27.
42. García AGa, Sampedro FG, Rey JG, Vila PG, Martin MS. Pell-Gregory classification is unreliable as a predictor of difficulty in extracting impacted lower third molars. *British Journal of Oral and Maxillofacial Surgery*. 2000;38(6):585-7.
43. Hupp JR, Tucker MR, Ellis III E. *Contemporary oral and maxillofacial surgery*: Elsevier Health Sciences; 2013.
44. Baqain Z, Al-Shafii A, Hamdan A, Sawair F. Flap design and mandibular third molar surgery: A split mouth randomized clinical study. *International Journal of Oral and Maxillofacial Surgery*. 2012;41(8):1020-4.
45. Osunde O, Adebola R, Saheeb B. A comparative study of the effect of sutureless and multiple suture techniques on inflammatory complications following third molar surgery. *International Journal of Oral and Maxillofacial Surgery*. 2012; 41(10):1275-9.
46. Pasqualini D, Cocero N, Castella A, Mela L, Bracco P. Primary and secondary closure of the surgical wound after removal of impacted mandibular third molars: A comparative study. *International Journal of Oral and Maxillofacial Surgery*. 2005;34(1):52-7.

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