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EFFECTIVENESS OF DIFFERENT ROUTES OF CORTICOSTEROID ADMINISTRATION ON POSTOPERATIVE COMPLICATIONS ASSOCIATED WITH IMPACTED MANDIBULAR THIRD MOLAR SURGICAL EXTRACTION (A RANDOMIZED CONTROLLED CLINICAL TRIAL)

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ABSTRACT

Aim: The aim of this study is to evaluate the effectiveness of several routes for corticosteroid (methylprednisolone) administration in management of postoperative complications following impacted mandibular third molar surgery.

Materials and methods: Forty individuals with impacted mandibular third molars were divided and allocated randomly into 4 equal groups. **Group 1** (Intraosseous-Osseous Injection ***"IOI"),*** **Group 2** (submucosal injection ***"SMI"***), **Group 3** (Tablet ***"TAB"***), and **Group 4** (negative control ***"NC"***). The clinical parameters that were assessed postoperatively are pain, trismus and facial swelling.

Results: At day 1, the mean pain intensity was 3.2± 1.14, 4.1±0.99, 4.9±1.66 and 4.7±1.34 within the 4 groups respectively (p= 0.038). By day 3, pain decrease was statistically significant in group 1. Finally, by day 7, there was no statistically significant difference among all groups. At day 1, the NC group has the highest increase of facial swelling (p<0.001). By day 3, the first two groups showed the highest decrease (p=0.444). Finally, by day 7, the better result was among group 1 and 2. One day post-operatively, there was a significant decrease in mouth opening in all the groups (p <0.001). By day 3 and 7, there was a statistically significant difference concerning the mouth opening between the IOI and NC groups.

Conclusion: Following mandibular third molar surgery, Both IO and SM injections showed nearly same effects on post-surgical pain, facial swelling, and trismus. These results suggest that the SMI approach may still be the technically easier option.

KEYWORDS: Impacted mandibular third molar; corticosteroids; methylprednisolone; intraosseous injection; submucosal injection

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INTRODUCTION

The degree of difficulty in removing an impacted mandibular third molar has been connected to postoperative inflammatory complications and other morbidities. These sequalae directly affect the patient's quality of life in the postsurgical period. [1] Also, Inflammation and pain are the physiological responses of body tissues to any type of injury, and they differ from patient to patient where inflammatory mediators (prostaglandins, leukotrienes, bradykinin, etc.) are released into the tissues, resulting in vascular dilation and permeability, generating oedema, and amplifying the interstitial tissue response. [2, 3]

In order to reduce this postoperative inflammatory process, the use of corticosteroids has been advised, as they were found to reduce the physiologic processes that characterise inflammation, such as local heat, redness, swelling, and soreness. [4]

Moreover, in a way to control postsurgical discomfort, trismus, and oedema, various corticosteroids such as betamethasone, triamcinolone, prednisolone, hydrocortisone, dexamethasone, methylprednisolone, and others are administered. However, many clinicians are hesitant to use corticosteroids in conjunction with oral surgery due to worries about probable side effects, particularly infection and adrenal suppression, even though the latter has only been observed with long-term use. [5, 6]

Corticosteroid delivery after impacted mandibular third molar surgery has been documented using a variety of methods, including intramuscular, submucosal, intravenous, and oral routes, in addition to intra-alveolar powders. [7] Furthermore, a study has found that intraosseous administration of steroid had a similar effect as submucosal injection in terms of lowering pain and oedema following impacted mandibular third molar surgery. However, it has a much lesser efficacy in reducing trismus than submucosal injection. [8]

The Steroids that function as immune suppressors inhibit inflammation in both its early and late phases. The enzyme phospholipase A2 is inhibited by corticosteroids, which lowers the release of arachidonic acid at the inflammatory site. As a result, prostaglandin production and Leukotrienes and neutrophil accumulation are both reduced. The production and/or release of inflammatory and pro-inflammatory mediators is inhibited by a single glucocorticoid dosage in a wide range of surgical procedures. [9, 10]

The aim of this study is to evaluate the effectiveness of several routes for corticosteroid administration in management of postoperative complications including pain, oedema, and trismus. The corticosteroid administration methods investigated in the current study included the oral tablet form, submucosal injection and intraosseous injection following impacted mandibular third molar surgery and they were compared to a negative control group where no steroids were administered.

PATIENTS AND METHODS

The current investigation is a randomized, double-blind, controlled clinical trial and was carried out following the CONSORT guidelines of clinical trials. Forty individuals with impacted mandibular third molars were chosen for this study, from the Outpatient Clinics of the Department of Maxillofacial Surgery, Faculty of Dentistry, Alexandria University. Informed consents were obtained from all patients. The study was carried out after receiving ethical approval from the Research Ethics Committee of Alexandria University's Faculty of Dentistry , and carried out in accordance with the Declaration of Helsinki on medical protocol and ethics.

Sample size calculation:

The sample size was estimated by the aid of the epitools.auvest.com.au website. From a similar study conducted by Kaewkumnert et al [8], the means were taken, and the variance was calculated, then the confidence level was set to be 0.95 and the power of the study was set to 0.8; the estimated sample size was 36 patients. Ten percent was added to the sample size to compromise the loss from the sample

throughout the follow-up period of the study, therefore a total of 40 patients were included to participate to this clinical trial.

Patients were selected according to some inclusion criteria; comprising patients with mesioangular class II position B impacted mandibular third molar according to Pell and Gregory classification, with age ranging from 18-35 years old and good oral hygiene. On the other hand, diabetics, hypertensive patients, pregnant women, patients with infection or purulent discharge, heavy smokers (those who smoke 25 cigarettes per day or more) or alcoholic patients, patients with medication allergies, and patients on anticoagulant or corticosteroid therapy were excluded from the trial.

The selected 40 patients were then randomly allocated into 4 different equal groups each consisting of 10 patients, using computer-generated randomization table website; randomizer.org as follows:

Group 1 (Intraosseous-Osseous Injection ***"IOI"):*** where patients received 40 mg/ml methylprednisolone intraosseous injection (Depo Medrol Pfizer, New York, NY 10017, USA) into the bone distal to the socket of impacted lower third molar immediately after extraction of the third molar and before suturing.

Group 2 (submucosal injection ***"SMI"***): where patients received 40 mg/ml methylprednisolone submucosal injection (Depo Medrol Pfizer, New York, NY 10017, USA) into the buccal vestibule opposite to the surgical site of impacted lower third molar immediately after surgery.

Group 3 (Tablet ***"TAB"***): where patients received 32 mg methylprednisolone tablet (Medrol Pfizer, New York, NY 10017, USA) immediately after surgical removal of impacted lower third molar.

Group 4 (negative control ***"NC"***): where patients did not receive any steroids after the surgical removal of impacted lower third molar.

Pre-operatively, mouth opening, and facial oedema were measured for all patients in all groups to serve as a baseline for further comparison after surgery.

For Pain assessment, it was measured using visual analogue scale (VAS) from zero to 10 and maximum inter-incisal mouth opening was measured with vernier callipers placed on the incisal edge of the maxillary and mandibular central incisors. while, the mean facial swelling was measured by a thread recording the facial dimensions, which were then converted to a uniform calibrated scale. The horizontal facial oedema was calculated as the distance between the corner of the mouth and the earlobe attachment. By palpating and identifying the inferior border, the vertical measurement was taken as the distance from the outer canthus of the eye to the angle of the jaw.[11] The facial measurement was calculated as: Horizontal measurement + vertical measurement / 2.

After recording the previous baseline measurements, each patient had a cone beam computed tomography (CBCT) taken to evaluate third molar eruption, angulations versus the adjacent second molar, the amount of bone covering the impacted mandibular third molar, the type of impaction, and the relationship between the roots of the impacted mandibular third molar and the inferior alveolar canal.

Intraorally, all patients in all groups were prepared by washing their mouths with antiseptic mouthwash immediately prior to the surgery, then local anaesthesia of the inferior alveolar and lingual nerve block, and long buccal nerve infiltration was administrated in form of Mepivacaine Hydrochloride 3% with 0.05 mg levonordefrin injection (Alexandria Pharmaceuticals and Chemical Industries (AXPH), Alexandria, Egypt).

All surgeries were done using extended buccal flap technique. After elevation of a full thickness mucoperiosteal flap, bone guttering was done buccally and distally together with mesial sectioning of

the interlocked cusps. The tooth was then extracted, the sharp bone smoothened with bone file, the socket debrided and irrigated with saline followed by wound suturing with 3-0 black silk sutures.

Before wound suturing in the intraosseous group (Group 1) , drilling (with a 0.8 mm diameter fissure bur) into the cortex at the central point of the buccolingual plane, located about 5 mm distal to the socket wound, was performed. Cone beam computed tomography (CBCT) was used to determine the distance between the point of drilling and the inferior alveolar canal, and the depth of drilling was limited by a rubber stopper placed in the 0.8 mm diameter fissure bur to ensure that the depth of drilling was at least 2 mm away from the inferior alveolar canal. Then, injection with 3 ml plastic syringe containing 40mg/ml methylprednisolone was done through the drill hole, penetrating the cortical bone into the medullary bone. (Fig. 1)

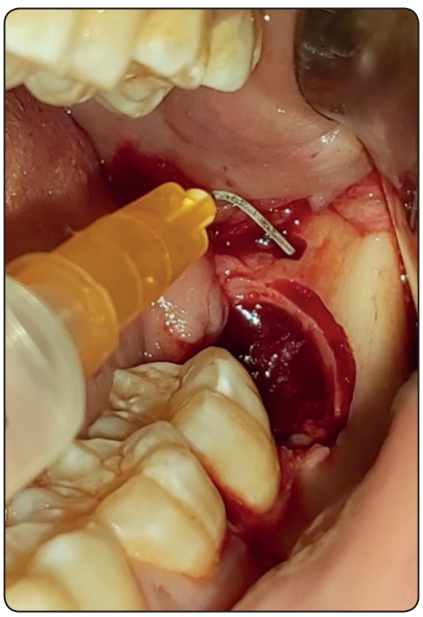

Fig. (1): Intraosseous injection of 40 mg/ml of methylprednisolone into the medullary bone through a drilled hole after surgical extraction of a lower third molar

Group 2 patients received submucosal methylprednisolone injection into the buccal vestibule opposite to the extraction site after wound suturing. Group 3 patients received methyl prednisolone tablet orally after surgery and finally group 4 was taken as a negative control group.

The following post-operative medications were prescribed for patients of all groups: Amoxicillin trihydrate 500 mg (Ibiamox, 500 mg, Amoun Co. Egypt) every 8 hours for 7 days, Paracetamol 500mg (Paramol Acetaminophen, MISR PHARMACEUTICALS, EGYPT) every 6 hours for 3 days, and 0.12% chlorhexidine mouth rinses twice a day for 7 days starting from the day following the operation.

All patients were instructed about cold fomentations on the day of surgery replaced by hot fomentation from the second day till the end of the week and following a soft diet. Suture removal was done after 7 days.

The clinical parameters that were assessed postoperatively are pain, trismus and facial swelling measured at days 1, 3, and 7 after surgery.

The IBM SPSS software programme (Armonk, NY: IBM Corp) version 20.0 was used to analyse the data. The Kolmogorov-Smirnov test was used to ensure that the distribution of variables was normal; ANOVA was used to compare the four groups, and the Post Hoc test (Tukey) was performed to compare pairwise comparisons. For abnormally distributed quantitative data, the Kruskal Wallis test was employed to compare distinct groups, followed by the Post Hoc test (Dunn's for multiple comparisons test) for pairwise comparison. The significance of the acquired results was assessed at a 5% level.

RESULTS

Each group consisted of 10 patients; sex distribution in these groups was almost similar: 5 men and 5 women in IOI group, 3 men and 7 women in SMI group, 4 men and 6 women in TAB group and 5 men and 5 women in the NC group. Age range was 18–26 years with the mean of 21.5± 2.3 , 22.7 ± 1.8,

21.6 ± 2.8 and 20.4 ±1.9 in the four studied groups respectively.

Pain

The pain intensity was measured using the VAS score, at days 1,3 and 7 post-operatively. The statistical analysis (Table 1) was done using Kruskal Wallis test, and the Pairwise comparison between each 2 groups was done using Post Hoc Test (Dunn's for multiple comparisons test). At day 1, the mean pain intensity ± SD was 3.2± 1.14, 4.1±0.99, 4.9±1.66 and 4.7±1.34 within the 4 groups respectively. The pain score was higher in the TAB and NC groups when compared to the first two groups; p= 0.038. By day 3, the intensity of pain is reduced within the 4 groups and the decrease was statistically significant in group 1 (IOI) when compared to the other 3 groups. Finally, by day 7, the decrease in pain continues among all groups, and there was no statistically significant difference between all of them.

TABLE (1): Comparison between the different studied groups according to post-operative pain intensity

Pain	Group IOI (n = 10)	Group SMI (n = 10)	Group TAB (n = 10)	Group NC (n = 10)	H	p
1st day						
Median (Min. – Max.)	3 (2 – 5)	4 (3 – 6)	5[a] (2 – 7)	4.5[a] (3 – 7)	8.413*	0.038*
Mean ± SD.	3.2 ± 1.14	4.1 ± 0.99	4.9 ± 1.66	4.7 ± 1.34		
p_0		0.135	0.009*	0.018*		
Sig. bet. grps.			p_1=0.261,p_2=0.379,p_3=0.807			
3rd day						
Median (Min. – Max.)	2 (1 – 3)	2.5[a] (1 – 4)	3[a] (2 – 4)	3[a] (2 – 4)	11.394*	0.010*
Mean ± SD.	1.7 ± 0.67	2.5 ± 0.85	2.7 ± 0.67	2.9 ± 0.74		
p_0		0.036*	0.009*	0.002*		
Sig. bet. grps.			p_1=0.596,p_2=0.299,p_3=0.610			
7th day						
Median (Min. – Max.)	1 (1 – 2)	1 (1 – 3)	1 (1 – 2)	2 (1 – 3)	5.445	0.142
Mean ± SD.	1.1 ± 0.32	1.5 ± 0.71	1.4 ± 0.52	1.7 ± 0.67		

p: p value for comparing between the different studied groups
p0: p value for comparing between IOI and each other groups
p1: p value for comparing between SMI and TAB
p2: p value for comparing between SMI and NC
p3: p value for comparing between TAB and NC
a: Significant with IOI
b: Significant with SMI
c: Significant with TAB
****: Statistically significant at p ≤ 0.05***

Swelling

The statistical analysis for the degree of swelling (Table 2) between the four groups was done using ANOVA test and the Pairwise comparison between each 2 groups was done using Post Hoc Test (Tukey). The degree of swelling was assessed in 4 intervals: pre-operatively as baseline measurements then at the 1st, 3rd and the 7th post-operative days. The mean of swelling measurements within the 4 studied groups preoperatively ranged between 10.71 as a minimum to 12.66 as a maximum. At the first post-operative day, the mean swelling was increased in all the groups; the NC group has the highest increase with a statistically significant difference when compared to the other groups $p<0.001$. Also, there was no statistically significant difference between the first group (IOI) and the second group (SMI). By the 3rd post-surgical day, the swelling began to decrease and again the first two groups showed the highest decrease, and there was no statistically significant difference in terms of swelling measurement between them (p=0.444). Finally, by the 7th post-operative day, the better results regarding the decrease in the degree of oedema was among group one and two with no statistical difference between them (p=0.925). Group three and four showed statistically significant difference in terms of swelling when comparing their results to the previous two groups.

TABLE (2): Comparison between the different studied groups according to swelling

Swelling	Group IOI (n = 10)	Group SMI (n = 10)	Group TAB (n = 10)	Group NC (n = 10)	F	p
Immediate preoperative						
Min. – Max.	9.89 – 11.78	9.78 – 11.78	10.54 – 13.87	10.56 – 15.23	10.093*	<0.001*
Mean ± SD.	10.72 ± 0.62	10.71 ± 0.61	12.13ab ± 1.14	12.66ab ± 1.36		
p_0		1.000	0.015*	0.001*		
Sig. bet. grps.		p_1=0.014*,p_2=0.001*,p_3=0.640				
1st day						
Min. – Max.	11.76 – 13.42	12.43 – 14.12	12.67 – 15.76	12.89 – 16.34	16.599*	<0.001*
Mean ± SD.	12.48 ± 0.52	13.19 ± 0.64	13.98a ± 1.01	14.99abc ± 1.05		
p_0		0.241	0.002*	<0.001*		
Sig. bet. grps.		p_1=0.174,p_2<0.001*,p_3=0.048*				
3rd day						
Min. – Max.	10.10 – 12.10	11.12 – 12.65	11.90 – 14.32	11.98 – 15.98	26.066*	<0.001*
Mean ± SD.	11.36 ± 0.58	11.9 ± 0.48	13.08ab ± 0.84	14.23abc ± 1.12		
p_0		0.444	<0.001*	<0.001*		
Sig. bet. grps.		p_1=0.010*,p_2<0.001*,p_3=0.013*				
7th day						
Min. – Max.	9.98 – 11.89	10.10 – 11.98	10.89 – 13.98	10.99 – 15.67	18.117*	<0.001*
Mean ± SD.	10.82 ± 0.61	11.08 ± 0.55	12.55ab ± 1.11	13.43ab ± 1.2		
p_0		0.925	0.001*	<0.001*		
Sig. bet. grps.		p_1=0.005*,p_2<0.001*,p_3=0.159				

p: p value for comparing between the different studied groups ***p0: p value for comparing between IOI and each other groups***

p1: p value for comparing between SMI and TAB ***p2: p value for comparing between SMI and NC***

p3: p value for comparing between TAB and NC ***a: Significant with IOI***

b: Significant with SMI ***c: Significant with TAB***

****: Statistically significant at p ≤ 0.05***

Trismus

The ANOVA and Post Hoc Tests were used for statistical analysis and comparison between the groups regarding the degree of post-operative trismus (Table 3). The baseline measurements were taken pre-operatively, where the mean and standard deviation for mouth opening was 43.5± 2.3, 42.2±2, 42.2±2.8 and 41.8± 2 within the 4 groups respectively. One day post-operatively, there was a significant decrease in mouth opening in all the groups p <0.001. While comparing the groups together, the statistically significant difference was between the SMI, TAB and NC groups and the IOI group. By the third post-surgical day, the mouth opening begins to improve in all groups; and there was a statistically significant difference between the IOI and NC group (p=0.021), but there was no statistically significant difference between the SMI, TAB and NC groups. At the 7th day, the mouth opening begins to return near the normal baseline measurements and there was a statistically significant difference between the negative control group and the IOI group (p= 0.001) and non-statistically significant difference between the SMI, TAB and NC groups.

TABLE (3): Comparison between the different studied groups according to TRISMUS

TRISMUS	Group IOI (n = 10)	Group SMI (n = 10)	Group TAB (n = 10)	Group NC (n = 10)	F	p
Immediate preoperative						
Min. – Max.	39.8 – 46.2	39.8 – 45.5	38.2 – 45.9	38.8 – 44.4	0.986	0.410
Mean ± SD.	43.5 ± 2.3	42.2 ± 2	42.2 ± 2.8	41.8 ± 2		
1st day						
Min. – Max.	28.5 – 37.8	26.9 – 33.3	24.2 – 32.9	24.8 – 31.9	8.043*	<0.001*
Mean ± SD.	33.6 ± 2.6	30.2[a] ± 1.9	29.3[a] ± 3	28.5[a] ± 2.3		
p_0		0.021*	0.002*	<0.001*		
Sig. bet. grps.		p_1=0.849,p_2=0.451,p_3=0.902				
3rd day						
Min. – Max.	33 – 41.6	30.7 – 38.8	29.8 – 39.1	29.9 – 37.8	3.651*	0.021*
Mean ± SD.	37.3 ± 2.8	35 ± 2.6	34.8 ± 3.2	33.2[a] ± 2.6		
p_0		0.225	0.207	0.012*		
Sig. bet. grps.		p_1=0.999,p_2=0.507,p_3=0.582				
7th day						
Min. – Max.	37.9 – 45.1	38.8 – 42.9	36.4 – 44	33.1 – 41.2	5.697*	0.003*
Mean ± SD.	42.5 ± 2.4	40.8 ± 1.7	40.1 ± 2.5	38.2[a] ± 2.7		
p_0		0.392	0.116	0.001*		
Sig. bet. grps.		p_1=0.894,p_2=0.082,p_3=0.306				

p: p value for comparing between the different studied groups
p0: p value for comparing between IOI and each other groups
p1: p value for comparing between SMI and TAB
p2: p value for comparing between SMI and NC
p_3: p value for comparing between TAB and NC
a: Significant with IOI
b: Significant with SMI
c: Significant with TAB
****: Statistically significant at p ≤ 0.05***

DISCUSSION

Surgical extraction of impacted wisdom teeth is an invasive treatment that causes significant tissue trauma and a significant postoperative inflammatory reaction. Although the inflammatory process is required for healing, it can produce pain, oedema, and limited mouth opening if it is aggravated which delay healing and reduce the patient's quality of life.[12]

The physiologic process of local heat, redness, swelling, and discomfort that characterises inflammation was discovered to be suppressed by corticosteroids. [13] In the current study, Methylprednisolone was chosen because it has less mineralocorticoid effects while having a high biological activity. Furthermore, it has a half-life of 18-36 hours and is 5-fold more effective than other corticosteroids, including hydrocortisone.

Forty patients with mesio-angular class II position B impacted lower third molars , were chosen to contribute in this study to evaluate the efficiency of different methods of methylprednisolone administration (Intra-osseous injection, Submucosal injection, post-operative tablet) and to compare them to a negative control group in terms of reduction of post-operative complications (pain, swelling and trismus) following the surgical removal of mandibular third molars.

The patients were randomly allocated into four groups, each with ten participants. Group 1 received intra-osseous methylprednisolone injection, Group 2 got a 40 mg/ml submucosal injection of methylprednisolone into the buccal vestibule opposite the surgical site of the impacted lower third molar , after surgical extraction of the lower third molar, Group 3 got a 32 mg methylprednisolone tablet and finally, group 4 was the negative control group.

Because it has limited mineralocorticosteroid activity and maintains a therapeutic plasma level during the early postoperative phase, methylprednisolone was chosen for this study. When it comes to the ideal dosage of methylprednisolone, the literature is conflicting. While Kim et al. [13] advocate a dose of 125 mg, other researchers suggest a dose of no more than 40 mg to avoid potential side effects. Alcantara et al [14] employed 40 mg of methylprednisolone, which is equivalent to about 200 mg of cortisol, in their investigation. As a result, 32 mg tablets and 40 mg/ml ampoules of methylprednisolone were used in the current study to avoid any probable side effects. Also, Novak et al. [15] found that a single high dose of methylprednisolone, given over a short period of time, causes no problems. There were no side effects reported in this trial.

The intraosseous route was chosen for this study as it is an easy procedure that may be performed in dental clinic by a dentist. Intraosseous delivery of certain medications may have a longer duration of effect, implying that the marrow cavity may operate as a depot. [16] Similarly, submucosal injection was highly convenient for the surgeon since it was done in approximation to the surgical site, and it was also very suitable for the patient as it was injected in an already anaesthetized area. Despite the forementioned data, the oral route was more comfortable to the patient.

On the first, third, and seventh days after surgery, each patient was assessed for pain, facial oedema, and trismus.

Regarding pain, patients were asked to indicate the intensity of pain on a 10-point visual analogue scale. The pain intensity was declined within the four groups throughout the follow-up intervals. Although, better results were seen in the IOI and the SMI groups than the other two groups during the first post-surgical day, there was no statistically significant difference between all the tested group after one week of surgery. Our results disagree with Kaewkumnert et al [8] who found that pain intensity was more in IOI group than the submucosal injection as they stated that corticosteroids can be absorbed more quickly through the medullary vein when given intra-osseously and their analgesic action is dose dependent. This may be justified as a modest quantity of solution leaking from the distal wall of

the surgical extraction site was noticed at the end of administration using the IOI approach.

On other hand, our results are matching with Leone et al., who concluded that 1 mg/kg methylprednisolone is effective for relieving pain after surgical extraction of third molars, and found out that patients who took 30 mg of methylprednisolone orally were less in pain after the extraction of impacted lower third molars. [17]

Concerning the facial swelling, all patients suffered from post-operative oedema that was subsided over time. The patients within the first two groups; IOI and SMI had less swelling and better recovery. Due to the direct action of the medicine at the surgical site, Moraschini et al [18] reported that sub-mucosal injection of dexamethasone resulted in a statistically significant effect on the control of swelling. Another study found that using the submucosal injection approach enhanced patients' quality of life when compared to taking oral prednisolone orally. [19] Furthermore, Graziani et al [20] reported no difference in the degree of facial swelling between intra-alveolar corticosteroid powder and submucosal injection of the drug, which is consistent with the current investigation.

Regarding the trismus, all patients complained from limitation in mouth opening following the surgery. On the first day, patients within the IOI group were the least who suffered. By the 3rd and 7th post-surgical days, the results of trismus among the three studied groups were comparable. These findings are similar to those of Kaewkumnert et al [8] who declared that dexamethasone injected into the medullary bone may help with trismus by lowering the exudate around the muscles, but it may not be able to stop the muscles from inflaming. Also, Kulkarni and Kshirsagar [21] reported that methylprednisolone was more effective than dexamethasone in controlling edoema and trismus, but there was no significant difference in pain control. Moreover, previous research has shown that submucosal injections (SM) of dexamethasone, like intramuscular injections, can greatly improve post-operative trismus. [22]

CONCLUSION

Following mandibular third molar surgery, an IOI methylprednisolone in the mandible had a positive effect in lowering pain and edoema, which was comparable to that of an SMI. Furthermore, IO injections posed the risk of drug leakage if not properly administered as well as being a more difficult injection technique. Both IOI and SMI injection treatments showed nearly the same effects on post-surgical pain, facial swelling, and trismus. These results suggest that the SMI approach may still be the better option. Further research with larger samples is required to confirm the current results.

Conflicts of interests

The authors declare that there was no conflict of interest during conducting this study.

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