

Comparison and Evaluation of Role of Dexamethasone and Diclofenac Sodium in Control of Postoperative Pain and Swelling Following Third Molar Surgery: A Clinical Study

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ABSTRACT

Background and objective: Surgical extraction of third molar is one of the most common surgical procedures and is quite stressful for many patients. Extraction of third molar, as with any surgical procedure, results in an intense inflammatory response that consists of edema, erythema, pain, warmth, and loss of function. In this study, two different groups of drugs – dexamethasone and diclofenac sodium – were compared for efficacy in reducing postoperative pain and swelling.

Materials and methods: A total of 100 patients who had to undergo surgical removal of mandibular third molars were randomly divided into two groups, each group consisting of 50 patients. One group was administered 1 mg dexamethasone, 8th hourly for 3 days postoperatively. The other group was given 50 mg diclofenac sodium, 8th hourly for 3 days postoperatively. Pain and swelling were measured on the first, second, fifth, and seventh postoperative days.

Results: The results of this study showed that diclofenac sodium (a nonsteroidal anti-inflammatory agent) is an effective analgesic, while dexamethasone (a corticosteroid) has moderate analgesic activity. Dexamethasone is more effective than diclofenac sodium in controlling postsurgical swelling.

Conclusion and interpretation: In conclusion, dexamethasone acts as an anti-inflammatory agent and diclofenac sodium as an analgesic and the combination of these two drugs would be very effective than individually when extensive postoperative sequelae are expected.

Keywords: Dexamethasone, Diclofenac sodium, Pain, Swelling, Visual analogue scale.

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INTRODUCTION

The removal of impacted mandibular third molar is one of the most important and most frequently performed oral surgical procedures.¹ It involves trauma to soft tissue and bone, resulting in postoperative inflammation, significant pain, swelling, and dysfunction² as direct and immediate consequences of the surgical procedure.

The factors contributing to postoperative pain, edema, and dysfunction are complex, but many of the contributing factors are related to the inflammatory process.³ However, the inflammatory reaction often seems more pronounced than healing requires⁴ and is undesirable, as it adversely affects and delays the process of healing.

Increasing knowledge of mechanism of pain and inflammation has resulted in effective new measures of controlling postoperative pain and swelling. Pharmacologic strategies for minimizing the clinical manifestations of surgical injury are logically directed at blocking the formation or inhibiting the effects of mediators of acute inflammation.⁵ Several types of medications [Antihistamines, nonsteroidal anti-inflammatory drugs (NSAIDs), and steroids] have been used to inhibit these postoperative sequelae. In most studies, NSAIDs have been used to prevent postoperative pain and steroids have been used to control swelling and trismus.^{6,7}

However, of all the pharmacological agents tried, anti-inflammatory steroids appear to be the most successful, and remain in common usage.⁸ The use of corticosteroids to control the sequelae of inflammation primarily and followed by pain in third molar surgeries has been an area of dispute since its inception in the 1950s.

Dexamethasone is a potent, highly selective, long-acting, synthetic corticosteroid, which has anti-inflammatory

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action.⁹ Previous studies on use of dexamethasone to control postoperative edema have concluded with an emphasis that there is a great need for well-designed clinical research to further evaluate protocols for corticosteroid use.

Apart from corticosteroids, numerous NSAIDs have been developed, which are relatively selective for inhibition of the enzyme cyclooxygenase (COX). Cyclooxygenase is an essential component of prostaglandin (PG) production. Nonsteroidal anti-inflammatory drugs have a more selective mechanism of action than glucocorticoids and a favorable side-effect profile.

Diclofenac sodium is the most commonly prescribed NSAID worldwide.¹⁰ It is a phenyl acetic acid derivative with analgesic, anti-inflammatory, and antipyretic properties. Similar to other NSAIDs, its mechanism of action is thought to involve the inhibition of COX at the site of injury, leading to a reduction in prostaglandin synthesis from arachidonic acid.¹¹

Numerous previous studies have attempted to define the role of glucocorticoids in reducing the postoperative inflammatory response. Theoretically, a reduction in swelling and trismus should result in reduction in pain and hence analgesic requirements. However, no clear consensus of opinion of practice has emerged because published studies lack comparability with regard to patient selection, number of teeth removed, dosage, timing, and route of administration of drugs.¹²

This study was designed to compare the efficacy of a corticosteroid (dexamethasone) with an NSAID (diclofenac sodium) in limiting excessive postoperative pain and swelling.

MATERIALS AND METHODS

This prospective study was approved by the Human Studies Review board, after which 100 healthy adult patients, aged 18 to 55 years, gave their written consent to participate. They were among patients who were scheduled to undergo surgical removals of their mandibular third molars under local anesthesia. All patients who were selected were evaluated for their physical statuses and patients with systemic diseases that contraindicated

surgical removal of lower third molars under local anesthesia were excluded from the study. Patients were randomly divided into two groups of 50 each by using a simple, random sampling technique. Both the treatment groups underwent surgical removals of asymptomatic mandibular third molars under local anesthesia dentistry section by using strict aseptic techniques, with only minimal trauma being caused to the surrounding tissues.

One treatment group was prescribed tablet dexamethasone 1 mg, thrice daily for 3 days after the surgical removal of mandibular third molars. Other treatment group was prescribed tablet diclofenac sodium 50 mg, thrice daily for 3 days.

All the patients were under standard antibiotic coverage for 5 days. Patients were followed up on the first, second, fifth, and seventh postoperative days.

Facial swelling was determined by recording facial size postoperatively and comparing it with presurgical baseline measurements. Preoperative measurements were taken by marking six points on the face on the following facial landmarks; mandibular angle, tragus, lateral canthus of eye, alar base, lip commissure, and pogonion. With the mandibular angle as the base point, by using 3–0 silk suture to follow the contour of the face, linear distances to the other landmarks were noted. The sum of all measurements were taken as the facial size.¹³

Pain and swelling were recorded on first, second, fifth, and seventh postoperative days. Pain was recorded using 100 mm visual analogue scale (VAS). The end points of the scale were “no pain” and “pain could not be worse.” The means from VAS were classified as none/no pain 0 to 10 mm, mild pain 11 to 30 mm, moderate pain 31 to 60 mm, and severe pain 61 to 100 mm.¹⁴

RESULT

The dexamethasone group consisted of 33 (66%) males and 17 (34%) females. The age range of the patients was 18 to 56 years with a mean age of 27 years.

The diclofenac sodium group consisted of 20 (40%) males and 30 (60%) females. The age range of the patients was 12 to 78 years with a mean age of 27 years.

Table 1 shows the changes in facial measurement in the dexamethasone group. It shows mean difference

Table 1: Facial measurement (mm)

Time of assessment	Dexamethasone group			
	Mean ± SD	Difference from preoperative measurement (baseline)	% increase from baseline	p*-value
Preoperative (Baseline)	449.3 ± 27	0	0	–
Postoperative day one	462.5 ± 28.16	13.16	2.9	<0.001 HS
Postoperative day two	459.6 ± 27.483	10.3	2.3	<0.001 HS
Postoperative day five	453.42 ± 26.35	4.12	0.9	<0.001 HS
Postoperative day seven	449.34 ± 26.83	1.04	0.0	0.77 NS

*Paired student t test for intra-group variation; HS: Highly significant; NS: Nonsignificant

Table 2: Facial measurement (in mm)

Time of assessment	Diclofenac sodium group			
	Mean ± SD	Difference from preoperative measurement (baseline)	% increase from baseline	p*-value
Preoperative (baseline)	435 ± 20.9	0	0	–
Postoperative day one	473.8 ± 20.05	38.72	8.9	<0.001 HS
Postoperative day two	470.96 ± 20.80	35.86	8.2	<0.001 HS
Postoperative day five	463.66 ± 25.22	28.56	6.6	<0.001 HS
Postoperative day seven	435.2 ± 20.93	0.1	0.0	0.56 NS

*Paired student t test for intra group comparison; HS: Highly significant; NS: Nonsignificant

in facial measurement on postoperative day one, day two, day five, and day seven. There was increase in size by 13.16 (2.9%) on day one (p < 0.001) and 10.3 mm (2.3%) difference from preoperative measurement on postoperative day two (p < 0.001). There was 4.12 mm (0.9%) difference from preoperative measurement on postoperative day five (p < 0.001) and no statistically significant difference in the size of facial swelling between preoperative and postoperative day seven.

Table 2 shows changes in the facial measurement in the diclofenac sodium group. It shows mean difference in facial measurement on postoperative day one, day two, day five, and day seven. There was increase in facial measurement by 38.72 mm (8.9%) on postoperative day one (p < 0.001) and 35.72 mm (8.2%) increase in facial measurement on postoperative day two (p < 0.001) from preoperative measurement. There was 28.56 mm (6.6%) increase in facial measurement on postoperative day five (p < 0.001) and no statistically significant difference in facial size between preoperative and postoperative day seven.

Table 3 and Graph 1 show mean comparative efficacies of dexamethasone and diclofenac sodium in reducing facial swelling on postoperative day one, day two, day five, and day seven.

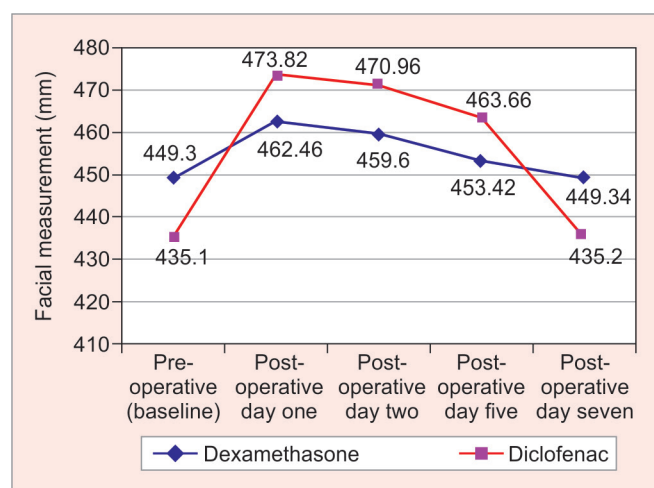
Table 4 shows changes in pain measurement in the dexamethasone group. It shows mean difference in pain experienced on VAS by the patient on the first, second, fifth, and seventh postoperative days. The mean pain on VAS on first postoperative day was 41.08 ± 16.85 mm, which lies in the range of “moderate pain.” On the second postoperative day, the mean pain score on VAS was 26.84 ± 12.07 mm, which relates to “mild pain.” The decrease in pain from the first postoperative day was by

14.24 mm (34.7%). On the fifth postoperative day, the mean pain on VAS was 14.3 ± 11.3 mm, which again relates to “mild pain” and decrease of pain by 26.78 mm (65.2%) compared with the first postoperative day. On the seventh day, the mean pain score on VAS was 6.56 ± 7.61 mm, i.e., “no pain,” and thus decrease of pain by 34.52 mm (84%) compared with the first postoperative day.

Table 3: Comparison of facial measurement between dexamethasone and diclofenac groups

Time of assessment	Mean difference	p*-value
Preoperative (baseline)	14.2	<0.05 S
Postoperative day one	11.36	<0.05 S
Postoperative day two	11.3	<0.05 S
Postoperative day five	10.24	<0.05 S
Postoperative day seven	14.14	<0.05 S

*Unpaired student t test for inter-group comparison; S: Significant



Graph 1: Reduction of facial swelling between dexamethasone and diclofenac groups

Table 4: Pain scores – dexamethasone (mm)

Time of assessment	Mean ± SD	Difference from preoperative measurement (baseline)	% decrease from baseline	p*-value
Postoperative day one	41.08 ± 16.85	–	0.0	–
Postoperative day two	26.84 ± 12.07	14.24	34.7	<0.001 HS
Postoperative day five	14.3 ± 1.3	26.78	65.2	<0.001 HS
Postoperative day seven	3.9 ± 2.9	37.18	90.5	<0.001 HS

*Wicoxon's signed rank test; HS: Highly significant

Table 5: Pain scores – diclofenac sodium

Time of Assessment	Mean ± SD	Difference from preoperative measurement (baseline)	% decrease from baseline	p*-value
Postoperative day one	29.58 ± 10.98	0	0	<0.001 HS
Postoperative day two	16.16 ± 6.61	13.4	45.4	<0.001 HS
Postoperative day five	7.08 ± 9.49	22.5	76.1	<0.001 HS
Postoperative day seven	3.9 ± 8.5	25.68	86.8	<0.001 HS

*Wicoxon's signed rank test; HS: Highly significant

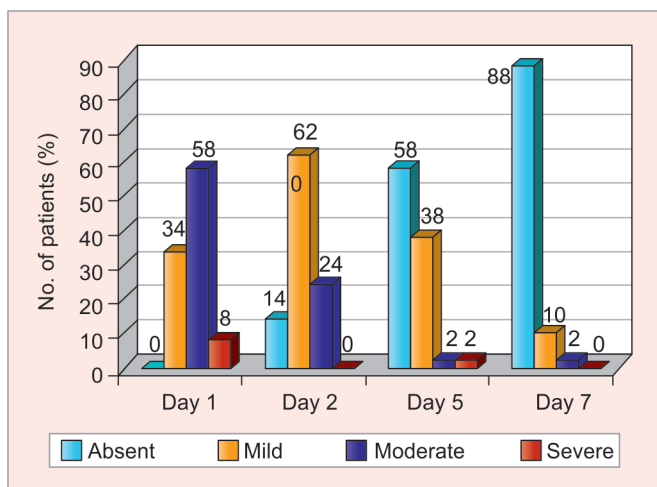
Table 6: Pain scores – diclofenac sodium

Time of Assessment	Mean ± SD	Difference from preoperative measurement (baseline)	% decrease from baseline	p*-value
Postoperative day one	29.58 ± 10.98	0	0	<0.001 HS
Postoperative day two	16.16 ± 6.61	13.4	45.4	<0.001 HS
Postoperative day five	7.08 ± 9.49	22.5	76.1	<0.001 HS
Postoperative day seven	3.9 ± 8.5	25.68	86.8	<0.001 HS

*Wicoxon's signed rank test; HS: Highly significant

Table 5 and Graph 2 show the incidence of pain experience in the dexamethasone group on the postoperative first, second, fifth, and seventh days. On the first postoperative day, 17 patients (34%) had mild pain, 29 (58%) had moderate pain, and 4 (8%) had severe pain. On second postoperative day, 7 patients (14%) had no pain, 31 (62%) had mild pain, 12 (24%) had moderate pain. On the fifth postoperative day, pain was absent in 29 (58%) patients, there was mild pain in 19 (38%) patients, moderate pain in 1 (2%) and severe pain in 1 patient (2%). On the seventh postoperative day, 44 patients (88%) had no pain, 5 patients (10%) had mild pain, and 1 (2%) patient had moderate pain.

Table 6 shows changes in pain measurement in the diclofenac sodium group. It shows mean difference in pain experienced on VAS by the patients on the first, second, fifth, and seventh postoperative days. The mean pain on VAS on the first postoperative day was 29.58 ± 10.98 mm, which lies in the range of "mild pain."



Graph 2: Pain on different postoperative days in dexamethasone group

On the second postoperative day, the mean pain score on VAS was 16.16 ± 6.61 mm, which relates to "mild pain." The decrease in pain from the first postoperative day was by 13.4 mm (45.4%). On the fifth postoperative day, the mean pain on VAS was 7.08 ± 9.49 mm, i.e., "no pain," and decrease of pain by 22.5 mm (76.1%) compared with that on the first postoperative day. On the seventh day, the mean pain score on VAS was 3.34 ± 8.55 mm, which means "no pain," and thus decrease of pain by 26.3 mm (88.7%) compared with that on the first postoperative day.

Table 7 and Graph 3 show the incidence of pain experience in the diclofenac sodium group on the first, second, fifth, and seventh postoperative days. On the first postoperative day, 31 patients (62%) had mild pain, 17 (34%) had moderate pain, and 2 (4%) had severe pain. On the second postoperative day, 10 patients (20%) had no pain, 38 patients (76%) had mild pain, and 2 patients (4%) had moderate pain. On the fifth postoperative day, in 45 patients (90%) pain was absent, in 4 patients (8%) there was mild pain, and 1 (2%) patient had severe pain. On the seventh postoperative day, 47 patients (94%) had no pain, 2 patients (4%) had mild pain, and 1 patient had moderate pain.

Tables 8 and 9 and Graphs 2 to 5 show mean comparative efficacies of dexamethasone and diclofenac sodium in reducing pain on postoperative day one, day two, day five, and day seven.

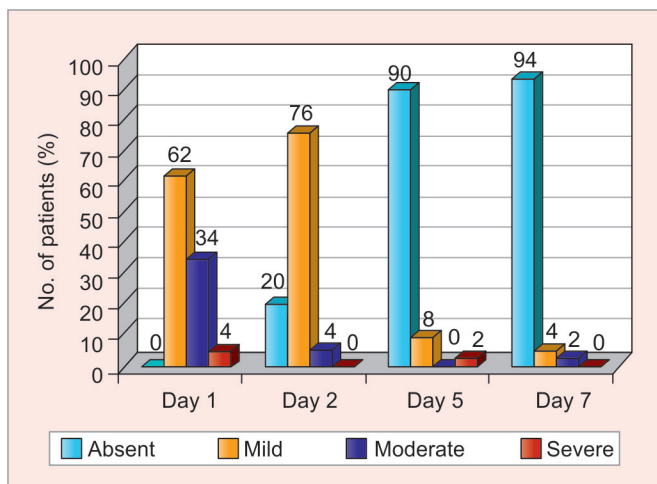
Table 7: Postoperative pain scores – diclofenac sodium (%)

Pain	Day 1	Day 2	Day 5	Day 7
Absent	0	10 (20)	45 (90)	47 (94)
Mild	31 (62)	38 (76)	4 (8)	2 (4)
Moderate	17 (34)	2 (4)	0	1 (2)
Severe	2 (4)	0	1(2)	0
X2 value	-	24.55	83.16	88.70
Significance	-	p <0.001 HS	p <0.001 HS	p <0.001 HS

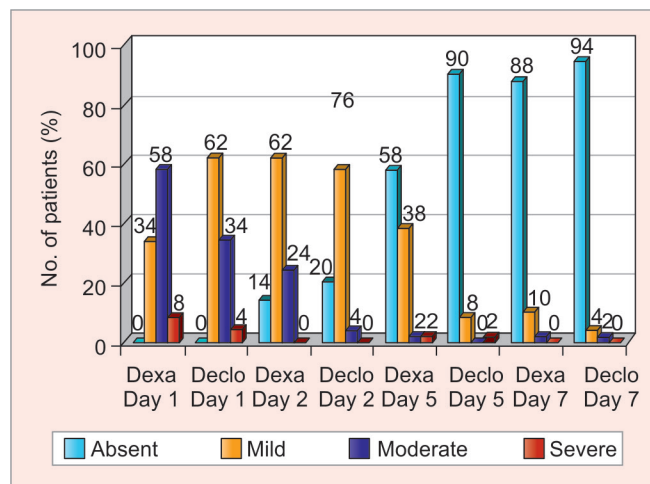
*Chi square test; HS: Highly significant



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Graph 3: Pain of different postoperative days in diclofenac group



Graph 4: Comparison of pain on different postoperative days between dexamethasone and diclofenac groups

Table 8: Comparison of pain between dexamethasone and diclofenac groups

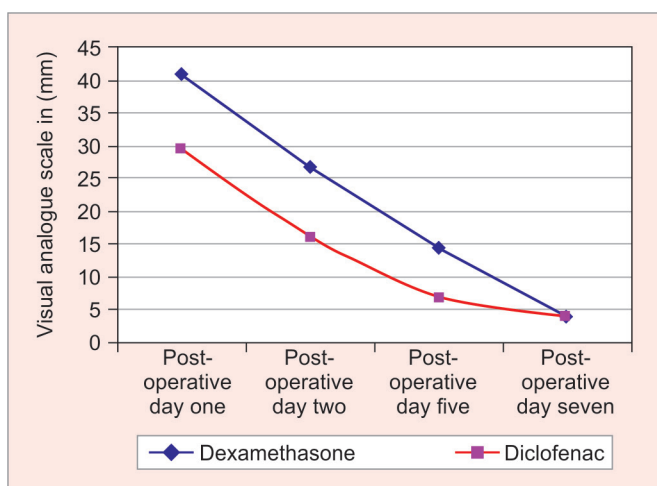
Time of assessment	Mean difference	Median		p*-value
		Dexamethasone	Diclofenac	
Postoperative day one	11.5	38	26	<0.001 HS
Postoperative day two	10.68	27	15	<0.001 HS
Postoperative day five	7.22	10	6	<0.001 HS
Postoperative day seven	0	3.9	3.9	0.05 NS

*Mann whitney u test; HS: Highly significant; NS: Nonsignificant

Table 9: Comparison of pain on different postoperative days between dexamethasone and diclofenac groups

Pain	Day 1		Day 2		Day 5		Day 7	
	Dexa#	Diclo+	Dexa	Diclo	Dexa	Diclo	Dexa	Diclo
Absent	0	0	7 (14)	10 (20)	29 (58)	45 (90)	44 (88)	47 (94)
Mild	17 (34)	31 (62)	31 (62)	38 (76)	19 (38)	4 (8)	5 (10)	2 (4)
Moderate	29 (58)	17 (34)	12 (24)	2 (4)	1 (2)	0	1 (2)	1 (2)
Severe	4 (8)	2 (4)	0	0	1 (2)	1(2)	0	0
X2 value	7.88		8.38		14.242		1.38	
Significance	p <0.05 S		p <0.05 S		p <0.01 S		p >0.05 NS	

– Dexamethasone; + – Diclofenac sodium; S: Significant; NS: Nonsignificant



Graph 5: Comparison of pain measurement between dexamethasone and diclofenac groups

DISCUSSION

Surgical extraction of impacted third molar is one of the most common procedures in oral surgery and is quite stressful for many patients.¹⁵ Extraction of the third molar, as with any surgical procedure, results in an intense inflammatory response that consists of edema, erythema, pain, warmth, and loss of function. The inflammatory response is, of course, not always beneficial to the host as it may exceed the necessary physiologic limits and result in excessive swelling, pain, and trismus.¹⁶ This inflammatory reaction often seems more pronounced than healing requires.⁴ Also, if it becomes excessive or chronic, it may result in the progressive destruction of tissue and a whole host of untoward systemic effects.¹⁷

The pain after the extraction of impacted lower third molars is one of the most representative models of postoperative pain and is frequently used for the evaluation of analgesic drugs.^{18,19} One of the main reasons for the wide usage of this pain model is that it allows the predictable development of pain and inflammation in young patients without systemic pathology in whom the surgical extraction of impacted lower third molars is indicated.²⁰ Surgery of impacted lower third molars is known to cause more intense pain than any other oral surgical procedures.¹⁶

Many attempts have been made to control postoperative pain, the results being satisfactory only to some extent.²¹

The characteristic features of inflammatory reaction are not caused by the tissue damage itself. They are caused by chemical agents called mediators of inflammation, which are formed when tissues are damaged. Some mediators are derived from the cells and others are derived for proteins in blood plasma.²²

One of the key events in the acute inflammatory process is the liberation of arachidonic acid from damaged cell membranes upon exposure to phospholipase A₂. This step can be inhibited indirectly by a powerful group of anti-inflammatory agents known as glucocorticoids. From this point, the oxidative metabolism of arachidonic acid can proceed along two divergent pathways. One pathway uses the enzyme COX, also known as PG endoperoxide synthase, whereas the second uses the enzyme lipoxygenase. Virtually all cells in the body, with the exception of red blood cells, contain the COX enzyme, whereas lipoxygenase appears to be limited in inflammatory cells (neutrophils, mast cells, eosinophils, and macrophages).¹⁷

Other important mediators of inflammation include nitric oxide and bradykinin. Nitric oxide produces hyperalgesia. Bradykinin has striking pharmacologic effects in human beings. It is a potent but transient vasodilator of both arteries and veins by a direct action on smooth muscle. In extraction sockets, local concentrations of immunoreactive bradykinin as well as PGs rise in patients after the removal of impacted third molar teeth. All these phenomena implicate bradykinin in various aspects of acute inflammatory reactions, including acute pain.¹⁷

Edema of varying amounts occurs after every surgical intervention and should be expected. Greater degrees of tissue injury lead to greater amounts of edema.²³ Maximal edema after surgical extraction of impacted lower third molar was found to occur 24 to 72 hours after the surgery.^{24,25}

There has been a constant search for ways to control the inflammatory process, starting with the use of pressure dressings and thermal agents and extending to the use of various pharmacological agents.²⁶ Accordingly,

an ideal drug for administration after the surgical removal of an impacted lower third molar should alleviate pain, reduce inflammation, trismus, facilitate healing, and cause no undesirable side effects.¹⁶

Much research has been done on drugs to minimize postoperative pain and swelling. Nonsteroidal anti-inflammatory drugs are the oldest and most widely used drugs in human history. These have both pain-relieving (analgesic) effects and effects of reducing inflammation and fever. They relieve pain without interacting with the opioid receptors, are nonaddictive, and do not cause significant CNS depression as seen with opioid analgesics. Most NSAIDs are nonselective, i.e., both COX-1 and COX-2 enzymatic inhibitors.²⁷

Nonsteroidal anti-inflammatory drugs are often recommended after surgical extraction of impacted lower third molar to abolish postoperative pain.²⁸ Clinical experience has shown, however, that no single NSAID is universally effective or tolerated.² Although some drugs may be effective in certain patients, they may cause severe side effects in others. Tolerance and safety have thus become important factors to consider in selection of NSAIDs.²

Adverse effects, owing largely to inhibition of the constitutive housekeeping enzyme cyclooxygenase-1, are common, particularly in the elderly, and include dyspepsia, nausea, and gastric damage in chronic users, with risk of hemorrhage, less commonly, liver disorders and bone marrow depression.²⁷

The most commonly used ones are the NSAIDs that inhibit the synthesis of prostaglandins and thromboxanes, reducing their action on sensitive nerve terminals, as well as their chemotactic and vessel-dilating actions. Among them, diclofenac sodium has showed its efficacy in several studies.

Diclofenac sodium, an orally administered NSAID, has been shown to be useful in controlling postoperative pain.²⁹ Although indicated for the treatment of the signs and symptoms associated with the painful conditions of osteoarthritis and rheumatoid arthritis, diclofenac sodium is also effective in a variety of acute pain settings, such as postoperative oral surgery pain.¹⁰ Diclofenac sodium has exhibited analgesic activity in various models of acute pain, including post-surgical dental pain.¹⁰ Also it is the most commonly prescribed NSAID worldwide.¹¹

The effect of steroids on postsurgical sequelae of third molar removal has been evaluated in many clinical trials. Most studies have reported that steroids significantly reduce the swelling, pain, and trismus. Few have not shown any benefit from the administration of steroids. These studies are difficult to compare because a variety of steroids were evaluated using dissimilar study designs and methods for evaluating swelling and pain.¹³

Dexamethasone is a potent, highly selective, long-acting synthetic corticosteroid, which has anti-inflammatory action.³⁰ It has been used by oral surgeons since 1965 in an attempt to reduce pain and swelling following surgery.

Pain is not as troublesome to assess as facial swelling but assessment relies heavily on patient cooperation and interpretation of pain. Also, pain and swelling are inter-related and are sequelae of surgical trauma.¹³ As stated earlier, VAS was used in the present study to assess pain.

In a study by Baxendale et al,¹² the dexamethasone group consisted of 37% male and 63% female patients. The age range was 18 to 45 years, with mean age being 23.7 years. Five patients in the dexamethasone group required no postoperative analgesia, compared to one patient in the placebo group. It was concluded that use of prophylactic oral dexamethasone is useful in reducing postoperative analgesia requirements and may facilitate surgery performed on a day-case basis.

A study by Anne Pedersen²⁹ consisted of 30 healthy individuals, 57% females and 43% males. The age range was 15 to 30 years, with mean age being 22 years. The results showed that prophylactic steroid administration led to about 30% reduction in postoperative pain.

In the present study, the dexamethasone group consists of 33 (66%) males and 17 (34%) females. The age range of the patients is 18 to 56 years, with a mean age of 27 years.

In a study by Caci and Gluck,³¹ in patients receiving prednisolone, 95.2% experienced slight pain. In the placebo group, 75% of patients experienced pain. However, pain was significantly improved ($p < 0.05$) for Prednisolone when compared with placebo and papase. This is the only study that has shown improvement in trismus and pain, but not edema, when a corticosteroid is used perioperatively.

In the present study, in the dexamethasone group, the mean pain on VAS on the first postoperative day was 41.08 mm and 34% of patients had mild pain, 58% had moderate pain, and 4% had severe pain. Mean pain experienced by patients on the second postoperative day was 26.84 mm and 14% of patient had no pain, 62% had mild pain, and 24% had moderate pain. On the fifth postoperative day, mean pain was 14.3 mm and in 58% of patients pain was absent, 38% cases had mild pain, 2% cases had moderate pain, and 2% had severe pain. On the seventh postoperative day, mean pain was 6.56 mm and 88% cases had no pain, 10% had mild pain, and 2% had moderate pain.

Studies by Hooley and Francis,³² Skjelbred and Lokken³⁰ and Van Zwan³³ showed that pain was significantly reduced due to prophylactic steroid administration. Also, dexamethasone in particular appears to decrease pain after surgery.³⁴

In the present investigation where dexamethasone was administered postoperatively, the effect on pain was not statistically significant. This discordance might be due to 2–3 times higher steroid doses in the previous studies.^{30,32,33} This present study was further supported by Baxendale BR et al,¹² Graziani et al,³⁵ and Anne Pedersen.²⁹

Walton et al,³⁶ Hersh et al,¹¹ and Zuniga et al,³⁷ in their respective studies, concluded that diclofenac sodium provided significant pain relief after surgical removal of lower third molars when compared to placebo. In a study comparing corticosteroids and NSAIDs, Sisk and Bonnington³ showed that corticosteroids were the drug of choice in preventing edema; however, NSAIDs may be required for better pain relief.

A study by Moore et al,³⁸ concluded that the combination of preoperative rofecoxib 50 mg and intraoperative dexamethasone 10 mg was most effective in minimizing pain and trismus following third molar surgery.

Bamgbose et al³⁹ showed that coadministration of dexamethasone and diclofenac was significantly superior to diclofenac alone for the relief of pain, and facial swelling up to postoperative 48 hours. However, there was no significant difference for trismus relief between the two medication protocols.

Buyukkurt et al,⁴⁰ concluded that the combination of a single dose of prednisolone and diclofenac is well suited to the treatment of postoperative pain, trismus, and swelling after dental surgical procedures and should be used when extensive postoperative swelling of soft tissue is anticipated.

Hyrkas et al⁴¹ concluded that a combination of methylprednisolone and diclofenac resulted in greater pain relief than with the administration of diclofenac alone.

It is well known that steroids suppress the immune function, increasing the potential risk of infection. In the present study, we did not encounter any case of infection in the dexamethasone group because we used glucocorticosteroid only for 3 days. A larger sample and patients not treated with antibiotics may be necessary in order to assess the incidence of infection, with the prophylaxis being a very controversial matter.

Thus, the present study showed that dexamethasone is more effective than diclofenac sodium in reducing postoperative swelling and diclofenac sodium is an effective analgesic, while dexamethasone has moderate analgesic activity.

We tried to compare the results obtained in the present study with those of other authors, but we found that those were done with different drugs, doses, and administration routes, with placebo instead of corticoids and NSAIDs and using different pain and swelling assessment systems.

The results of this study appear that a single class of drugs is not maximally effective in controlling both postoperative pain and swelling. Diclofenac sodium (an NSAID) is an effective analgesic, while dexamethasone (a corticosteroid) has moderate analgesic activity. Dexamethasone is more effective than diclofenac in controlling postsurgical swelling. A combination of these two medications may be necessary to control the sequelae of oral surgical procedures more effectively.

A study by Lopez-Carriches et al⁴² compared the analgesic efficacy of methyl prednisolone and diclofenac sodium and stated that there was less pain in the corticoid group but not as to justify its routine use. This is in agreement with the studies by Hooley and Francis,³² Skjelbred and Lokken³⁰ and Van Zwan.³³

The study by Lopez-Carriches et al⁴² consisted of 58.4% females and 41.6% of males; the age range being 18 to 35 years with mean age of 23.2 years. This study showed that pain score on VAS in the diclofenac sodium group on the first postoperative day was 7.6 mm and 38.9% of patients had mild pain, 41.7% had moderate pain, and 19% had severe pain. The values on the second postoperative day was 36 mm and 16.7% of patients had no pain, 33.3% had mild pain, 41.7% had moderate pain, and 6.3% had severe pain. On the fifth postoperative day, the value was 22.02 mm and 58.3% of patients had no pain, 13.9% had mild pain, 27.8% had moderate pain, and none had severe pain. This study did not record values on the seventh postoperative day.

In the present study, 50 mg diclofenac sodium given thrice daily postoperatively significantly affected postoperative pain. It consisted of 20 (40%) males and 30 (60%) female patients. The age range of the patients was 12 to 78 years with a mean age of 27 years. In the present study, in the diclofenac group, the mean pain on VAS on the first postoperative day was 29.58 mm and 62% of patients had mild pain, 34% had moderate pain, and 4% severe pain. Mean pain experienced by patients on the second postoperative day was 16.16 mm and 20% of patients had no pain, 76% had mild pain, and 4% had moderate pain. On the fifth postoperative day, mean pain was 7.08 mm and in 90% of patients pain was absent, in 8% cases there was mild pain, and 2% had severe pain. On seventh postoperative day, mean pain was 3.34 mm and 94% cases had no pain, 4% had mild pain, and 2% had moderate pain.

In a study by Henrikson et al,¹⁴ the mean pain score for the first 5 days in the diclofenac group was 11.6 mm and for the last 2 days the mean pain score was 12.8 mm. Thus, it showed that as the medications were stopped, pain increased on the 6th and 7th day.

In the present study, the mean pain scores kept on decreasing till the 7th day. Also, it was found that pain did not increase after stopping the medication.

There is a controversy about the appropriate moment to administer the anti-inflammatory medication, with a tendency to do it before pain appears. This seems quite logical because pain reaches its maximum level between 3 and 8 hours after surgery, and at that time, the anti-inflammatory agent should have reached a high concentration in plasma. But in the present study, no preemptive drugs were prescribed.

Thus, in the present study, diclofenac sodium, an NSAID, proved to be a better analgesic when compared to a steroid, Dexamethasone, contrary to the above study by Lopez-Carriches et al,⁴² where they had compared diclofenac sodium to methylprednisolone. This is in agreement with the studies by Troullos et al⁵ and Sisk and Bonnington³ where they had compared a steroid, methylprednisolone, and an NSAID, Fluribiprofen, and concluded that NSAIDs appear to be effective analgesics.

Postsurgical swelling affects the daily life of patients.¹⁰ Many authors have advocated the use of corticosteroids to limit postoperative edema due to their suppressive action on transudation,^{23,43,44} but few have made definitive recommendations supported by randomized clinical trials.^{23,29}

Quantitative assessment of swelling represents a major difficulty. Postsurgical facial edema is difficult to quantify accurately, since it requires a three-dimensional measurement with an irregular, convex surface and can manifest itself internally as well as externally. Over the years, numerous researchers have tried various techniques in an effort to objectively measure edema,^{14,23} most of which are indirect assessments of the altered contours of skin surface. Measurement tools mentioned in the literature have included VAS, trismus recordings, standardized stereo-radiographic or photographic measurements, computerized tomography, linear measurement, vernier callipers to measure cheek girth, modified face bow devices, ultrasonography, facial plethysmographs, or various other means of taking direct facial measurements.^{5,23} No technique has been proved to be superior or more accurate in analyzing swelling.¹³ The desire to include large number of patients and the practicality of a low-cost, reliable technique made linear measurements a feasible choice in the present study.

A study conducted by Baxendale et al¹² on dexamethasone for reduction of swelling following extraction of third molar teeth concluded that the dexamethasone group had more patients with mild swelling and fewer patients with severe swelling.

Another study was conducted by Elhag et al⁸ for establishing anti-inflammatory effects of dexamethasone. It was concluded that dexamethasone group had mean swelling volumes significantly lesser ($p < 0.05$) than the controls. But at such a high dose of 10 mg dexamethasone,

there was suppression of the hypothalamic–pituitary–adrenal axis, as demonstrated by marked reduction in plasma cortisol in the dexamethasone group.

Using the patients as their own controls, Messer and Keller⁴⁵ concluded that there is a predictable decrease in edema in the dexamethasone group in comparison with patients who did not receive dexamethasone.

Graziani F et al,³⁵ reported that Dexamethasone significantly reduces facial edema, especially on the second postoperative day when maximum facial swelling is expected. Also with increase in dosage from 4 to 10 mg of dexamethasone, a greater reduction in swelling was observed.

A study conducted by Ware et al,⁴⁶ concluded that Dexamethasone did indeed decrease edema and trismus, but statistical analysis was not significant. If more patients had been included in this study, a significant difference may have been demonstrated.

Linenberg⁴⁷ reported significant clinical improvement in postoperative swelling in the dexamethasone group after extraction of mandibular third molars.

In the present study, administration of dexamethasone resulted in significantly less degree of swelling on the first postoperative day ($p < 0.001$). There was 2.9% increase from preoperative facial measurement on first postoperative day. There was further reduction of swelling on second postoperative day ($p < 0.001$) and 2.3% increase from the preoperative measurement on the second postoperative day. By the fifth postoperative day, the swelling was only 0.9% more than the preoperative measurement. The facial size reached the preoperative facial measurement by the seventh day. This was in agreement with various studies by Baxendale BR et al,¹² Graziani et al,³⁵ Anne Pedersen.²⁹

But contrast with the above studies and the present study, Neupert et al,¹³ and Edilby and Gennitt⁴⁸ showed that there was no significant decrease in swelling between dexamethasone and control groups.

Henrikson et al,¹⁴ concluded in their study that diclofenac treatment group had significantly less swelling compared with the patients in fixed combination tablet treatment group. Thus, this study showed that diclofenac sodium can be used as an agent to control postoperative swelling.

In the present study, administration of diclofenac sodium resulted in 8.9% increase from preoperative facial measurement on first postoperative day. There was 8.2% increase from the preoperative measurement on the second postoperative day and by the fifth postoperative day the swelling was 6.6% more than the preoperative measurement. The facial size reached the preoperative facial measurement by the seventh day.

In the present study, it was concluded that diclofenac sodium does decrease postoperative swelling but not as

much as in comparison to dexamethasone. The control of swelling was statistically in favor of dexamethasone.

In a study comparing corticosteroids and nonsteroidal anti-inflammatory agents, Sisk and Bonnington³ showed that corticosteroids were the drug of choice in preventing edema; however, NSAIDs may be required for better pain relief.

A study by Moore et al³⁸ concluded that the combination of preoperative rofecoxib 50 mg and intraoperative dexamethasone 10 mg was most effective in minimizing pain and trismus following third molar surgery.

Bamgbose et al³⁹ showed that coadministration of dexamethasone and diclofenac was significantly superior to diclofenac alone for the relief of pain, and facial swelling up to postoperative 48 hours. However, there was no significant difference for trismus relief between the two medication protocols.

Buyukkurt et al⁴⁰ concluded that the combination of a single dose of prednisolone and diclofenac is well suited to the treatment of postoperative pain, trismus, and swelling after dental surgical procedures and should be used when extensive postoperative swelling of soft tissue is anticipated.

Hyrkas et al⁴¹ concluded that a combination of methylprednisolone and diclofenac resulted in greater pain relief than with the administration of diclofenac alone.

It is well known that steroids suppress the immune function, increasing the potential risk of infection. In the present study, we did not encounter any case of infection in the dexamethasone group because we used glucocorticosteroid only for 3 days. A larger sample and patients not treated with antibiotics may be necessary in order to assess the incidence of infection, with the prophylaxis being a very controversial matter.

Thus, the present study showed that dexamethasone is more effective than diclofenac sodium in reducing postoperative swelling and diclofenac sodium is an effective analgesic, while dexamethasone has moderate analgesic activity.

We tried to compare results obtained in the present study with those of other authors, but we found that those were done on different drugs, doses, and administration routes, with placebo instead of corticoids and NSAIDs and using different pain and swelling assessment systems.

The results of this study suggest that a single class of drugs is not maximally effective in controlling both postoperative pain and swelling. Diclofenac sodium (an NSAID) is an effective analgesic, while dexamethasone (a corticosteroid) has moderate analgesic activity. Dexamethasone is more effective than diclofenac in controlling postsurgical swelling. A combination of these two medications may be necessary to control the sequelae of oral surgical procedures more effectively.

CONCLUSION

In this study, dexamethasone proved to be a potent anti-inflammatory agent. Although previous studies question the analgesic efficacy of this drug, in our study it appeared that this drug showed satisfactory results and pain may decrease because of decrease in inflammation. Although diclofenac sodium is an anti-inflammatory drug, its efficacy in reducing postoperative swelling is not satisfactory. But it proved to be an effective analgesic agent.

With the present study, we conclude that the steroid dexamethasone acts as an anti-inflammatory agent and diclofenac as an analgesic and the combination of these two drugs would be very effective than as an individual drug when extensive postoperative sequelae are expected.

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