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Effect of Immediate Post Operative Cryotherapy in the Management of Pain, Swelling and Mouth Opening Following Mandibular Third Molar Surgery - A Randomized Clinical Study

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Abstract: ***Introduction: Dentoalveolar surgery involves some post-operative sequelae comprising of pain, swelling and dysfunction. Surgical removal of impacted mandibular third molars constitutes a large proportion of minor oral surgical procedures and generally involves these sequelae. This calls for attention regarding an easier and cost-effective way of managing these undesirable post-surgical conditions. Aims: This study aims to throw light on the effectiveness of cold compression therapy on pain, swelling, trismus following removal of impacted mandibular molars. Materials and methods: A single-blind randomized clinical study consisting of two groups (Experiment and Control) is chosen. Surgical removal of impacted mandibular third molar was carried out using standardized protocol. The inferior alveolar nerve and the lingual nerve were anaesthetized by administering 2% lignocaine combined with 1:200,000 adrenaline. A standardized surgical technique was undertaken. Patients in experimental group were subjected to 45 minutes of repeated intermittent ice compression with POLAR ICE PACK ™ after the surgery. It has very high cold retention capacity as compared to dry and wet ice. When used with properly, it is guaranteed to maintain cold condition for up to 30 hours. POLAR ICE PACK ™ is 100% non toxic and non carcinogenic. Those in control group were left alone without any local ice application. Results: cryotherapy had significant effect on pain, swelling and mouth opening on 2nd and 7th post operative days, overall effect of immediate ice pack compression on outcome variables seemed to be insignificant when compared to control group. Conclusion: Cold compression therapy proves to be the oldest and easiest method for preventing postop sequelae such as pain, swelling and trismus***

Keywords: Cold compression therapy, Cryotherapy, Dentoalveolar surgery, Third molar

1. Introduction

Surgical removal of impacted mandibular third molar is a routine procedure in Oral and Maxillofacial Surgery. These procedures involve trauma to the soft tissues and bony structures of oral cavity resulting in post operative pain, swelling and difficulty in mouth opening[1]. According to Savin and Ogden,[2] one-third of patients will feel a marked disinclination to socialize for at least one week after third-molar extraction, and the fact that one in five patients claimed that they would not recommend third molar extraction. Because of the consistency of these outcomes, recovery after third molar surgery is often used as a model for studying the efficacy of analgesic and anti-inflammatory drugs for this and other procedures affecting bone and connective tissue. This model is recommended by the US Food and Drug Administration for these reasons and because patients having third molar surgery are usually healthy without complicating medical conditions[3].

The many factors that contribute to these situations are complex, but they originate in an inflammatory process initiated by surgical trauma. Cyclo-oxygenase and prostaglandins play a crucial role in the development of postoperative pain and swelling during such reactions[4,5]. According to Knight (1995),[6] the physiological responses to primary injury may lead to a secondary injury by means of enzymatic and hypoxic mechanisms that affect the peripheral cells of the primary injury. The secondary injury caused by post-trauma hypoxia is due to several factors such as bleeding from the injured vessels, hemostasis, decreased blood flow due to increased blood viscosity and increased extravascular pressure and swelling caused by injury of the cellular membrane, that may occlude small vessels further, increasing the ischemic area (Fisher, 1990). Then, in the first hours after the primary injury there is an increase in the total area of injury, which is a consequence of the secondary injury[7,8]. Almost all patients report taking medications for pain, usually an opioid in combination with a nonsteroidal anti-inflammatory drug (NSAID), for at least the first few days after third molar surgery. In addition to prescribing these medications for control of pain, surgeons and other clinicians seek adjunctive measures to reduce inflammation and its related pain postoperatively[5,9].

Among the physical treatments to reduce pain, ice had its place for many years. Experience tells us that ice has a strong short-term analgesic effect in many painful conditions, particularly those related to the musculoskeletal system. Cryotherapy or cold therapy is the local or systemic application of cold for therapeutic purposes and has been in use as early as the time of Hippocrates. Ice therapy is low cost, easy to apply and readily available.

The first physiological response of the tissues to cryotherapy is a fall in the local temperature that leads to reduced cell metabolism. This causes the cells to consume less oxygen and survive a longer period of ischemia. The main function of ice on the circulatory system is reducing the blood flow effected by the vasoconstriction, reducing haemorrhage and limiting the extent of the injury[13,14]. Ice compression decreases the excitability of free nerve endings and peripheral nerve fibres, increasing the pain threshold. It is assumed that these results are achieved by influencing the haemodynamic, neuromuscular and metabolic processes[15,16,17].

Although several procedures have been reported for the use of ice (gel, spray, ice packs, immersion, etc.), in clinics, hospitals and sports activities ice packs are the most used. The use of bags of crushed ice or cold gel packs secured to various anatomical sites with bandaging or elastic wraps is a common observation in locker rooms of athletic facilities everywhere[5]. As cold compression therapy directly addresses the swelling, inflammation and pain associated with these injuries, this modality has been extended to the post-operative management of a variety of orthopedic procedures[18,19].

Despite the frequent use of cooling in orthopaedic rehabilitation and physiotherapy, as evidenced by the plethora of reports in the literature, there is a paucity of scientific evidence in the literature to justify treatment that is largely applied in an empirical manner[20,21].

In the present study, we investigate the effect of immediate post operative ice compression after mandibular third molar surgery on pain, swelling and mouth opening. Participants were grouped in to two groups. The study group received immediate ice pack compression after surgery and the control group received no compression. Postoperative pain was measured by visual analogue scale, reduction in swelling and improvement in mouth opening was measured in terms of millimeters. Outcome variables were assessed and compared between two groups.

2. Methodology

A single-blind randomized clinical study consisting of two groups (Experiment and Control) is chosen. Surgical removal of impacted mandibular third molar was carried out using standardized protocol after getting consent for participation in the study. The inferior alveolar nerve and the lingual nerve were anaesthetized by administering 2% lignocaine combined with 1:200,000 adrenaline. A standardized surgical technique was undertaken. Full mucoperiosteal flaps were elevated prior to the removal of the third molars. Alveolotomy and, if necessary, sectioning of the tooth was carried out using a bur under a concomitant continuous irrigation with sterile saline solution. Removal of the tooth was then performed followed by meticulous irrigation and debridement of the surgical area with sterile saline solution to eliminate debris. The flap was then repositioned and the wound sutured. Patients in experimental group were subjected to 45 minutes of repeated intermittent ice compression with POLAR ICE PACK ™ after the surgery. It is formulated with crystals of super absorbent polymer to keep temperature sensitive products safe during transportation. It has very high cold retention capacity as compared to dry and wet ice. When used with properly, it is guaranteed to maintain cold condition for up to 30 hours. POLAR ICE PACK ™ is 100% non toxic and non carcinogenic. It is harmless to handle and being reusable it is economical for repeated freezing and does not create any watery mess like ice. Those in control group were left alone without any local ice application. All the patients were given routine post operative instructions, antibiotics and analgesics. The following criteria were studied:

1) Pain level assessed with visual analogue scale (VAS).
2) Swelling assessed by measuring gonion- commissure distance with silk thread.
3) Mouth opening measured by using calipers

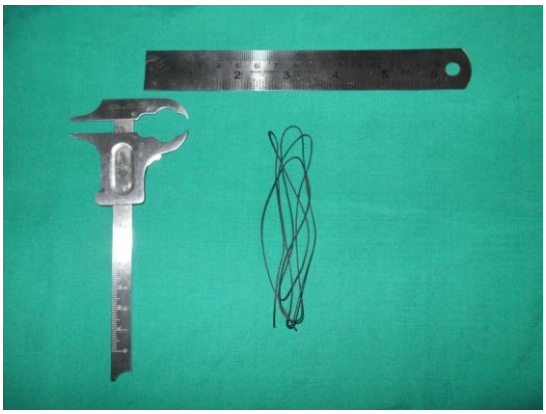


Figure 1: Armamentarium

Figure 2: Polar ice packs

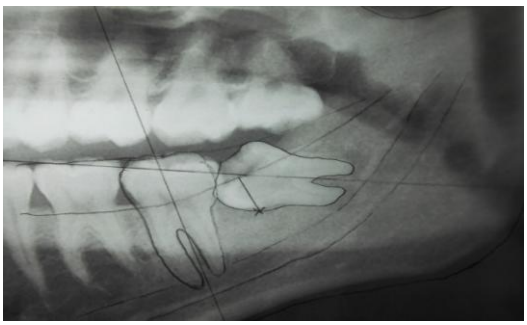


Figure 3: Orthopantomogram showing Pederson'sdifficulty score

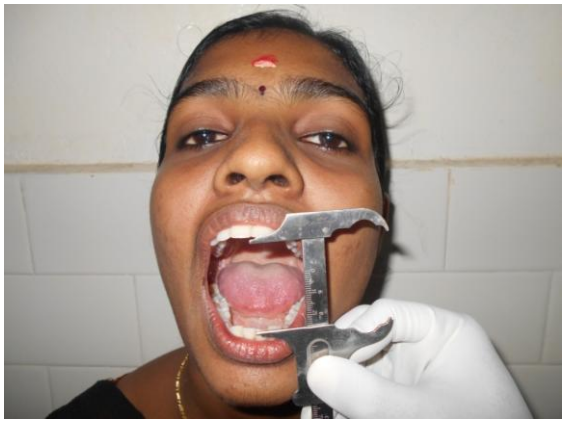


Figure 4: Pre-operative mouth opening measured using calipers

Figure 5: Postoperative 2nd day mouth opening

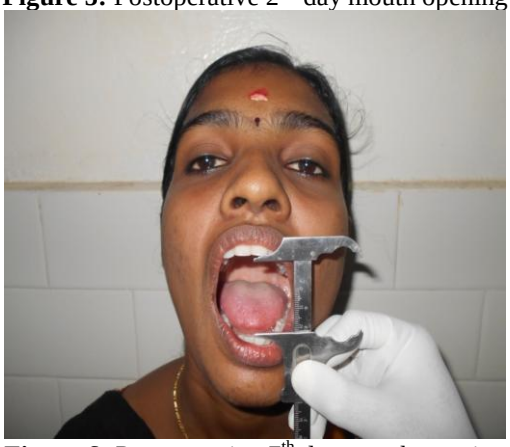


Figure 6: Postoperative 7th day mouth opening

Figure 7: Postoperative 2nd day swelling by measuring Gonion-Commissure length

Figure 8: Postoperative 7th day swelling

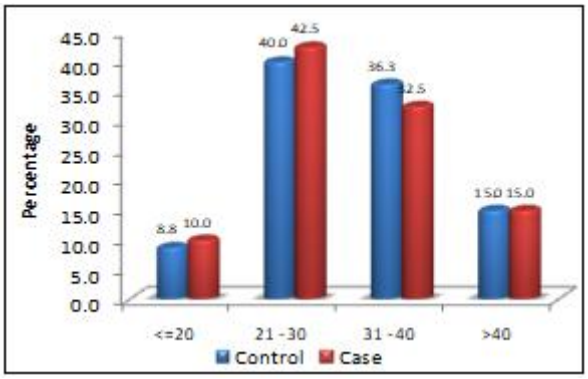
Figure 9: Ice pack compression

Table 1: Composite difficulty score of mandibular third molar impaction according to Pederson[23]

Parameter	Score
1. Winter's Classification (Wi)	
a. Distoangular	4
b. Vertical	3
c. Horizontal/Transverse	2
d. Mesioangular	1
2. Pell-Gregory classification- Ramus (Ri)	
a. Class 3	3
b. Class 2	2
c. Class 1	1
3. Pell-Gregory classification- Occlusal (Oi)	
a. Level C	3
b. Level B	2
c. Level A	1
Composite mandibular position score Ci = Wi + Ri + Oi	3-10

Table 2: Comparison of age based on group

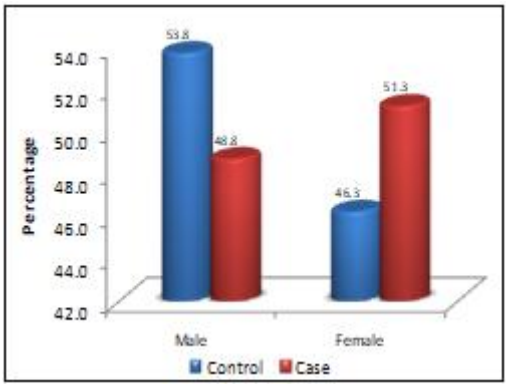
Age	Control group		Cryotherapy group	
	Count	Percent	Count	Percent
<=20	7	8.8	8	10.0
21 - 30	32	40.0	34	42.5
31 - 40	29	36.3	26	32.5
>40	12	15.0	12	15.0
Mean ± SD	31 ± 9.1		30.7 ± 9.7	



Graph 1: Comparison of age based on group

Table 3: Comparison of gender based on group

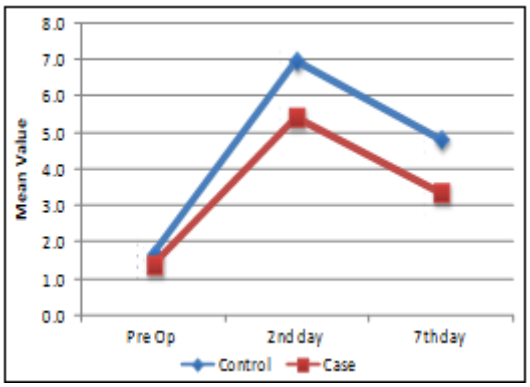
Sex	Control group		Cryotherapy group		χ^2	p
	Count	Percent	Count	Percent		
M	43	53.8	39	48.8	0.4	0.527
F	37	46.3	41	51.3		



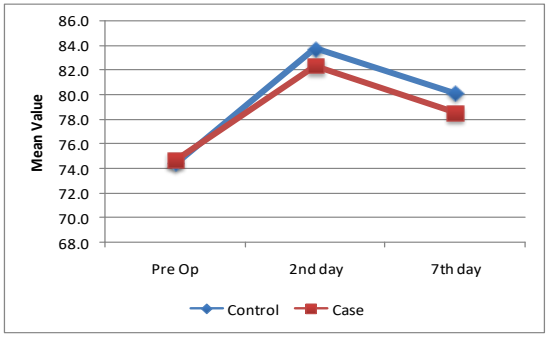
Graph 2: Comparison of gender based on group

Table 4: Comparison of pain at different interval of time based on group

		Mean	SD	N	t	P
2nd day	Control group	7.0	0.9	80	11.18**	0.000
	Cryotherapy group	5.4	0.8	80		
7th day	Control group	4.8	1.1	80	9.94**	0.000
	Cryotherapy group	3.4	0.8	80		



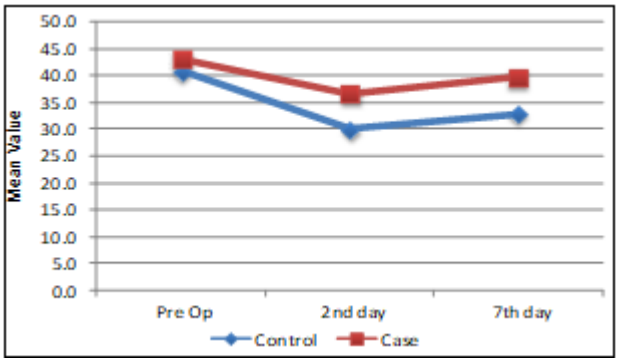
Graph 3: Comparison of pain at different interval of time based on group



Graph 4: Comparison of swelling at different interval of time based on group

Table 5: Comparison of swelling at different interval of time based on group

		Mean	SD	N	t	P
Pre Op	Control group	74.4	5.4	80	0.42	0.679
	Cryotherapy group	74.7	3.6	80		
2nd day	Control group	83.8	5.6	80	1.88	0.061
	Cryotherapy group	82.4	3.8	80		
7th day	Control group	80.2	5.1	80	2.23*	0.027
	Cryotherapy group	78.6	3.8	80		



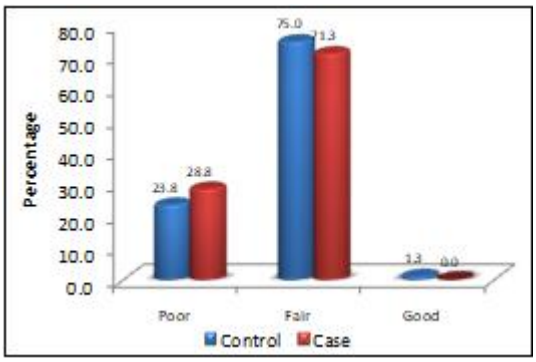
Graph 5: Comparison of mouth opening at different interval of time based on group

Table 6: Comparison of mouth opening at different interval of time based on group

		Mean	SD	N	t	p
Pre Op	Control group	40.9	4.5	80	4.01**	0.000
	Cryotherapy group	43.2	2.7	80		
2nd day	Control group	30.2	6.2	80	8.73**	0.000
	Cryotherapy group	36.7	2.5	80		
7th day	Control group	33.0	6.0	80	9.35**	0.000
	Cryotherapy group	39.8	2.7	80		

Table 7: Comparison of change in pain based on group

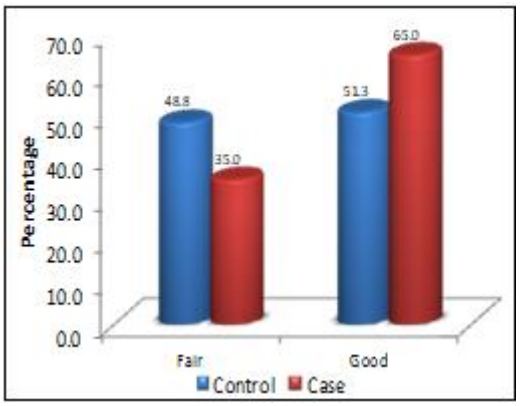
Pain	Control group		Cryotherapy group		Z#	p
	Count	Percent	Count	Percent		
Poor	19	23.8	23	28.8	0.84	0.403
Fair	60	75.0	57	71.3		
Good	1	1.3	0	0.0		



Graph 6: Comparison of change in pain based on group

Table 8: Comparison of change in swelling based on group

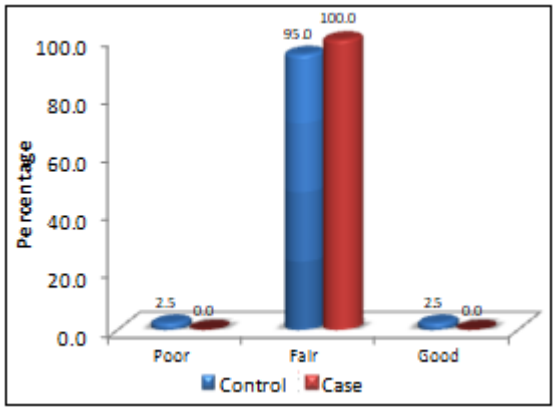
Swelling	Control group		Cryotherapy group		Z#	p
	Count	Percent	Count	Percent		
Fair	39	48.8	28	35	1.76	0.079
Good	41	51.3	52	65		



Graph 7: Comparison of change in swelling based on group

Table 9: Comparison of change in mouth opening based on group

Mouth opening	Control group		Cryotherapy group		Z#	p
	Count	Percent	Count	Percent		
Poor	2	2.5	0	0	0	1
Fair	76	95	80	100		
Good	2	2.5	0	0		



Graph 8: Comparison of change in mouth opening based on group

3. Results

All the variables were measured pre-operatively, 2nd and 7th Postoperative day (POD). Compared to control group (mean value 7.0 ± 0.9), Cryotherapy group had significant reduction in VAS score on second POD with ice compression (mean value 5.4± 0.8). On the seventh POD also there significant reduction in pain among the cases(3.4 Vs 4.8). Thus analysis showed that there was significant reduction in pain on 2nd and 7th POD following cryotherapy . Although preoperative Gonion-Commissure distance in both groups were almost same in our study, there was only mild decrease in swelling in Cryotherapy group as compared to control on 2nd POD (83.8 Vs 82.4). On the 7th day also, there was decrease in swelling in the interventional group (80.2 Vs 78.6). Both these changes had statistical significance (p value 0.05). Patients who had cryotherapy following surgical intervention showed marked improvement in mouth opening on the 2nd POD than the control group (36.7 Vs 30.2). On the 7th day also there is increase in mouth opening following ice compression (39.8 Vs 33.0). Although cryotherapy had significant effect on pain, swelling and mouth opening on 2nd and 7th post operative days, overall effect of immediate ice pack compression on outcome variables seemed to be insignificant when compared to control group.

4. Discussion

The removal of impacted third molars involves trauma to the soft tissues and bony structures of the oral cavity, resulting in pain and swelling. Review of literature shows that most of the patients after surgical extraction shows social isolation mainly due to physical appearance and bad mood. The many factors that contribute to these situations are complex, but they originate in an inflammatory process initiated by surgical trauma. Cyclo-oxygenase and prostaglandins play a crucial role in the development of postoperative pain and swelling during such reactions. Pain and swelling can be reduced using glucocorticoids, which have a membrane stabilizing and anti exudative effect; cyclo-oxygenase with non steroidal anti inflammatory drugs. In addition to these measures, several adjunctive methods are used by clinicians to reduce post operative pain and inflammation[1,3,14].

Cryotherapy is perhaps the simplest and oldest therapeutic modality in the management of acute soft-tissue damage caused by injuries or surgery. The mechanisms by which cryotherapy might elevate pain threshold include an anti-nociceptive effect on the gate control system, a decrease in nerve conduction, reduction, in muscle spasms, and reduction of edema after injury. Ice pack compression has wide spectrum of application in Orthopaedics especially in sports medicine in case of ankle sprains and ligament tears. Literature review shows a enormous number of studies on ice compression in Orthopaedic interventions, but only a few studies are seen pertaining to ice application in the field of Oral and Maxillofacial surgery[10,11,23].

In 2002, Enwemeka et al.[5] showed that ice packs are most commonly used modality for cryotherapy although other forms like gel, spray and immersions are commercially

available for use in hospitals, clinics and sport activities. Studies have shown that pain following surgical extraction reaches maximum intensity during the first 12 hours and 97% of patients experiences maximum pain levels on the day of operation. Because the benefits of cold compression therapy diminish with time, this intervention is thought to be most effective if applied almost immediately after injury or at the conclusion of an operative procedure[27,72].

Knight et al.[6] showed the mechanism of tissue injury following trauma or surgery. Immediately after surgery, primary inflammatory mechanism ensues. Following physiological response of primary injury, secondary injury may occur due to enzymatic and hypoxic mechanism that affects the peripheral cells. The secondary injury caused by post-trauma hypoxia is due to several factors such as bleeding of the injured vessels, hemostasis, decreased blood flow due to increased blood viscosity and increased extravascular pressure and swelling caused by injury of the cellular membrane, that may occlude small vessels further increasing the ischemic area.

Cryotherapy is the therapeutic application of cold to remove heat from the body. The first physiological response of the tissues to cryotherapy is a fall in the local temperature that leads to reduced cell metabolism. This causes the cells to consume less oxygen and survive a longer period of ischemia. Benefits attributed to local cold applications include, prevention of edema by reducing the accumulation of fluid in body tissues, reduction in inflammation, slowing of metabolism, controlling hemorrhage, retarding bacterial growth, decrease in excitability of free nerve endings and peripheral nerve fibers with resultant increase in pain threshold, decrease in enzymatic activity, temporary decrease in spasticity, and a facilitation of muscle contraction.

Lewis[73] proposed a "hunting response" during ice therapy, i.e. an initial vasoconstriction followed by a period of vasodilatation, which can reduce pain and subsequent capillary damage in the acute or subacute stages. Local hypothermia induces vasoconstriction and lowers microcirculation by more than 60%, an effect that can persist for up to 30 minutes after cessation of cooling. Cold induced vasoconstriction reduces extravasation of blood into surrounding tissues, local inflammation and edema production. The amelioration of pain associated with the direct application of cold to injured tissue is, in part, related to the reduction in edema formation as well as to decreases in motor and sensory nerve conduction A reduction in blood flow and swelling also can be achieved with compression by facilitating translocation of edema away from the site of injury and toward proximal noncompressed tissues where it can be resolved more efficiently by the lymphatic system. Importantly, the addition of cold to compression increases the rate, magnitude and depth of temperature reduction as well as the speed of lymph evacuation[74,75,76].

Ice therapy helps to reduce pain and swelling via a counter-irritation effect and the gate control theory of pain. The activation of the A delta fibres (large diameter fibres) can block the pain-gate by presynaptic inhibition , which stops the transmission of pain signals . In addition, the release of endorphins and encephalins and the counter-irritant effect of the sensation of cold also reduced pain through the pain gate theory. Cryotherapy raises the threshold for pain fibers and reduces nerve conduction velocity. Superficial nerves are effected most often, and sensory fibers are blocked before motor fibers. Even after removal of the cryotherapy, the effect may last up to 30 minutes. If the temperature of a peripheral nerve is reduced, its conduction is slowed. Unmyelinated fibers are less prone to this change than myelinated fibers, the A delta fibers are affected most[77,78,79]. The local application of cold suppresses the metabolic rate of the immediately surrounding soft tissue. This decrease in tissue metabolism is associated with a reduction in enzymatic activity, preventing tissue damage caused by hypoxia. The compression force during ice therapy improves contact between the ice and skin surface. This further increases the conductivity of the transmission of cold and maintains the cooling effect[80,81].

As stated earlier, few studies have been conducted about ice compression regarding duration, frequency and effect in the field of oral and maxillofacial surgery. The depth of the target tissue for cryotherapy is important to consider when deciding on mode of application. Skin and superficial tissues cool quickly, whereas cold penetration in deeper tissues is slower and less intense. Possoff[82] reported human cheek thickness as a mean of 15 mm and a range of 10 to 19 mm. He found only a 1°C decrease in alveolar mucosa temperature after 30 minutes of cryotherapy (ice bag wrapped in towel). Anatomic variation in subjects' jaw shape could impact the effectiveness of any cryotherapy.

The literature is unclear on the duration of cryotherapy necessary for clinical improvement. Local cooling may be provided either by direct contact with ice packs (natural or chemical), cool packs, bags of crushed ice, and other agents, or by vapor coolant sprays. The choice is usually based on cost and/or convenience. Coolant sprays are used primarily for short-duration superficial cooling to treat local trigger points or, for example, to provide analgesia prior to lancing an abscess. Deeper or more prolonged cooling requires the use of direct contact methods for 15-20 minutes. This method of application is useful in acute musculo-skeletal conditions for relief of pain, inflammation and muscle guarding, and it provides an analgesic effect superior to that of heat. Cooling may be applied every two to four hours in the acute phase. 9 to 15-minute intervals have been reported as successful for pain reduction, but at least 12 minutes is recommended to achieve local numbness. Changes in conduction of sensation occur at higher temperatures than the impact of cold in moderating inflammation[83,84,85].

In our study, we employed a regimen of 45 minutes of immediate post operative ice pack compression in view of the fact that any delay in cryotherapy can lead to decreased response on variable outcomes. Surgical removal of impacted mandibular third molar was carried out using standardized protocol. Patients in experiment group were subjected to 45 minutes of repeated intermittent ice compression after the surgery. Those in control group were left alone without any local ice application. All the patients were given routine post

operative instructions, antibiotics and analgesics. Following outcome variables were studied

1) Assessment of degree of pain as measured by VAS postoperatively.
2) Compare the post operative swelling with and without ice application by measuring Gonion-Commissure distance with silk thread.
3) Compare the post operative mouth opening measured by using calipers..
4) Overall effect of cryotherapy on pain, swelling and mouth opening.

Statistical analysis showed that immediate cryotherapy had marked effect in reducing pain, swelling and trismus postoperatively. Although cryotherapy had significant effect on pain, swelling and mouth opening on 2nd and 7th post operative days, overall effect of immediate ice pack compression on outcome variables seemed to be insignificant when compared to control group. For example, VAS score of a patient who had received ice pack compression on 2nd POD may be **6** and on 7th POD may be **3**. Similarly VAS score of patient without ice compression may be **8** on 2nd POD and **5** on 7th POD. In both the cases, the change in VAS Score is **3** which indicates that effect of ice compression on pain is FAIR . But from the above said values, it is clear that patient receiving ice compression definitely have a reduced VAS score on 2nd or 7th POD. This is the case with swelling and mouth opening also. So even though ice compression had significant effect in reducing pain, swelling and improving mouth opening, this was not reflected in the overall effect.

Although ice pack compression is relatively safe and effective adjunctive treatment after third molar surgery, no therapy is free of demerits and contraindications Cold therapy should be employed with caution in patients with hypertension, poor sensation, and in very old and very young as they may frequently have impaired thermal regulation or a limited ability to communicate. . Improper application of cryotherapy may result in tissue death due to prolonged vasoconstriction, ischemia, and capillary thrombosis. Incorrect application of cryotherapy can result in damage to the skin, namely frostbite. A barrier layer of material between the cold substance and the skin minimizes this rare complication. Freezing and reapplication of single-use chemical cold packs should be avoided because the toxic refrigerant may leak, resulting in tissue damage. In our study we used a sterile towel to wrap the ice packs to prevent direct contact of low temperature to the skin. Several cases of reversible total palsy after local cryotherapy have been described in the world literature. The phenomenon is explicable by the fact that nerve conduction is continually slowed down when temperatures fall, until finally nerve fibers cease conducting completely. Finally some of the specific contraindications to use of local cooling includes vasospastic conditions (Raynaud's Disease), cold hypersensitivity, cryoglobulinemia and paroxysmal cold hemoglobinuria[86,87].

A limitation of our study is that although we were able to prove that ice compression had significant effect in reducing pain, swelling and improving mouth opening, this was not reflected in the overall effect. Most of study participants were grouped under FAIR even though they had an improved relief than the values reflected in the overall effect. This was because of greater group interval employed between GOOD and FAIR in each of outcome variables to categorize them GOOD/FAIR/POOR. Also we were not able to conclude that whether it is the icepack or prolonged compression that had effect on pain, swelling and trismus after third molar removal.

5. Conclusion

Within the limits of the study, following conclusions were drawn

1) Immediate postoperative ice compression has a pronounced effect on reducing pain, swelling and improving mouth opening following surgical removal of mandibular third molars.
2) Cryotherapy should be applied for a duration of at least 45 minutes for getting the optimum result.
3) Ice pack compression is effective if applied immediately after surgery as delayed application may decrease the efficiency.
4) Adequate compression force is essential while applying ice pack as it improves the contact between the skin and ice pack.
5) Intermittent ice application is more comfortable than continous cryotherapy
6) Ice packs are more easy to apply and low cost than gels, sprays and immersions.

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