



CORTICOSTEROID INJECTION AT THE FRACTURE SITE AS AN EFFECTIVE METHOD OF PAIN RELIEF IN SINGLE RIB FRACTURES: A PROSPECTIVE STUDY.

Orthopaedics

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ABSTRACT

Background: Fracture of the ribs are common entities confronted by a physician while dealing with a polytrauma patient or a patient following injury to the chest. Even though a small fraction of them is life-threatening, it can delay the rehabilitation of the patient due to pain. Hence, we assessed pain relief using a novel method of injecting a combination of 1 ml 0.5% bupivacaine hydrochloride and 1 ml triamcinolone (40mg) directly at the fracture site.

Methods: This was a prospective comparative study done over a period of 12 months from November 2019 to October 2020. 92 patients were divided equally into 2 demographically comparable groups with one group given the injection at presentation, 2, and 4-week follow-up while the second group managed with just oral analgesics. The results were analysed by numerical rating scale under different conditions at each follow-up.

Results: The injection group showed significantly better short-term pain relief in all conditions with a faster return to daily activities.

Conclusion: This method provides efficient and lasting pain relief in patients with solitary rib fractures.

KEYWORDS

Rib fracture; corticosteroid; regional analgesia; anesthesia; pain relief

INTRODUCTION

Injuries to the thorax account for 10-15% of all trauma patients, with fracture of the ribs ranging from 7% to 38.7%^[1,2]. These occur most commonly following road traffic accident (RTA) or a fall^[2]. Patients present with severe pain on the affected side of the chest and flanks. The debilitating consequences of this pain such as restriction in the ability to cough, sneeze and deep inspiration makes the patient vulnerable to pulmonary morbidities such as atelectasis, pneumonia, and hemopneumo thorax, especially when associated major injuries are present or the patient is bed ridden. The pain can last for months, severely impeding the ability of the patient to resume normal day-to-day activities and rehabilitation, which makes pain control in this acute phase, crucial^[3].

Traditional modalities of analgesia include oral drugs such as non-steroidal anti-inflammatories (NSAIDs) and opioids, which provide short term relief. Other forms of intervention such as transcutaneous electrical nerve stimulation (TENS), Rib taping and analgesic patches have also been implicated with varying degrees of short-term pain relief^[4,5]. Invasive methods still remain the most efficient pain-control modalities namely surgical fixation, intercostal nerve block with local anaesthetic agent, and continuous blocks in the form of paravertebral or epidural blocks. However, each of these methods is associated with their respective complications and adverse effects such as prolonged hospital stay, infection and restriction of anti-coagulation therapy. Newer developments such as ultrasound guided cryoneurolysis are also in the works but require very high level of skill and knowledge^[6].

The mainstay invasive pain control method of intercostal nerve blocks with bupivacaine hydrochloride has also shown to be effective for a mere 6 hours in most patients possibly due to the high vascularity and subsequent systemic uptake of the anaesthetic agent^[6]. Hence, we undertook an alternate method of steroid injection with equal parts mixed local anaesthetic agent, injected directly over the fracture site in isolated rib fracture patients. This agent and dose selection was based on previous selective nerve blockade studies in which it was deemed safe for injection.^[7] The medium-term pain relief was postulated to be derived from subsidence of local inflammation by the corticosteroid component and the immediate relief from the neural effect of the local anaesthetic agent on the cutaneous, muscular, and periosteal branches of the intercostal nerves^[8-10]. We assessed the pain control based on

Numerical rating scale (NRS) at rest, while coughing, and deep breathing^[11]. To the best of our knowledge, this method of pain management for acute rib fractures has not been explored in any medical or orthopaedic literature.

OBJECTIVE

To assess the short-term degree and duration of pain relief in acute solitary rib fractures by locally injecting a combination of 1 ml 0.5% bupivacaine hydrochloride and 1 ml triamcinolone (40mg) at the site of the fracture.

MATERIAL AND METHODS

A prospective study was conducted over a period of 12 months from November 2019 to October 2020. Diagnosis was confirmed based on plain chest radiographs in the antero-posterior (AP) view or computerized tomography (CT) of the thorax. A total of 92 patients were enrolled and randomized into two equal groups (46 each). Inclusion criteria: (1) Age $\geq$ 18 years; (2) single rib fracture as diagnosed on chest radiograph; (3) Maximum NRS score of rib pain 7/10 at rest^[11].

Exclusion Criteria:

(1) Patients with flail chest, (2) multiple rib fractures, (3) head injury, (4) fractures of ipsilateral upper limb/clavicle, (5) blunt injury to abdomen or lumbar region, (6) pulmonary compromise or traumatic injury to the lungs, (7) pregnancy, (8) diabetes mellitus, (9) immunocompromised/on immunosuppressants, (10) patients with spinal injuries were excluded. Injection group was given a combination of 1 ml 0.5% bupivacaine hydrochloride and 1 ml triamcinolone (40mg) injection at the site of the fracture at presentation, 2 and 4-week follow-up. The procedure was done in supine position for anterior and lateral fractures, and in prone position for posterior fractures under strict aseptic conditions and on an out-patient basis (OPD) (Figure 1). The other group was treated with only oral analgesics in the form of tablet ibuprofen 400mg BD^[11-13] with a maximal allowance of an additional 400mg SOS, once a day. Demographic data was recorded and all the patients were followed-up at 2-, 4- and 6-weeks post-injury. The maximal severity of pain was recorded in the form of numerical rating scale (NRS) as assessed by the patients themselves, on (1) rest, (2) coughing, (3) deep inspiration and (4) rolling over to the affected side while sleeping. A decrease of NRS

scoring up to 3 was considered to indicate good pain relief^[11]. Owing to the potential inhibitory effects of corticosteroids on fracture healing, we also assessed whether the fracture healing time was affected, in addition to the time it took the patients to return to their daily work. Ethical clearance of the institutional review board was obtained along with written informed consent of all the patients enrolled. All the data was compiled and statistical analysis was performed using the SPSS software (SPSS Inc., USA). Data has been presented in the form of mean $\pm$ standard deviation (SD). The data distribution normality was determined by Kolmogorov-Smirnov goodness-of-fit test. Then two tailed Student's t-test was used to compare normally distributed data, while Mann-Whitney test was used to assess the non-normally distributed data. p values less than 0.05 were considered to be statistically significant.



Figure 1: Injection given for a patient in supine position with left sided anterior 4th rib fracture under all aseptic precautions in the OPD.

RESULTS:

A total of 42 patients from Group A and 36 patients from Group B complied with the pre-established follow-up protocol. The demographic data (Table 1) and the baseline NRS scores (Table 2)

were recorded and found out to be comparable in both the groups. The level of initial pain due to the fracture was found to be similar in both the groups under all conditions ($p > 0.05$). These patients were then followed-up with the aforementioned protocol and the NRS scores were recorded at rest, coughing, deep inspiration, and rolling over on the affected side at 2, 4- and 6-weeks post-presentation.

Table 1: Demographic Distribution And Clinical Results Of The Two Groups.

	Mean age ($\pm$ SD) *	Mal es	Fem ales	Mean time to fracture union ($\pm$ SD) *	Inter- group p value	Mean time to return to daily activities ($\pm$ SD) *	Inter- group p value
Ibuprofen group (n=36)	42.11 ($\pm$ 12.51) years	29	7	5.89 ($\pm$ 0.57) weeks	$p > 0.05$	5.67 ($\pm$ 0.63) weeks	$p < 0.05$
Injection group (n=42)	41.74 ($\pm$ 16.17) years	34	9	5.76 ($\pm$ 0.79) weeks		4.71 ($\pm$ 0.71) weeks	

*SD=Standard Deviation

As illustrated in Table 2, under all conditions, the intra-group pain relief in both the groups was statistically significant at the end of 4 and 6 weeks, as compared to the time of presentation ($p < 0.05$). The short-term pain relief (2 and 4 weeks) in the injection group was significantly higher on intragroup as well as on intergroup comparison ($p < 0.05$). In the long-term (6 weeks) however, the number was statistically and clinically insignificant between the two groups ($p > 0.05$).

Mean return to daily activity was significantly faster in the combination group (4.71($\pm$ 0.71) weeks vs 5.67($\pm$ 0.63) weeks) (Table 2). Time to fracture healing was unaffected by the local injection of the combination (5.76($\pm$ 0.79) vs 5.89($\pm$ 0.57) weeks), as shown by statistically insignificant difference in the healing between the two groups (Table 1), as determined by plain radiograph of the chest in AP view.

Table 2: Mean Pain Intensity According To NRS At Presentation And Each Follow-up ($\pm$ SD*)

Follow-up	Presentation			2-weeks					4-weeks					6-weeks				
	Ibuprofen Group	Injection Group	Inter-group baseline p value	Ibuprofen Group	Injection Group	Intra-group improvement p value		Inter-group improvement p value	Ibuprofen Group	Injection Group	Intra-group improvement p value		Inter-group improvement p value	Ibuprofen Group	Injection Group	Intra-group improvement p value		Inter-group improvement p value
						Ibuprofen group	Injection group				Ibuprofen group	Injection group				Ibuprofen group	Injection group	
Rest	4.39 $\pm$ 1.13	4.43 $\pm$ 1.04	$p > 0.05$	3.61 $\pm$ 1.08	3.43 $\pm$ 0.83	$p > 0.05$	$p < 0.05$	$p < 0.05$	2.44 $\pm$ 0.78	1.62 $\pm$ 0.79	$p < 0.05$	$p < 0.05$	$p < 0.05$	0.11 $\pm$ 0.32	0.07 $\pm$ 0.26	$p < 0.05$	$p < 0.05$	$p > 0.05$
Deep breathing	5.39 $\pm$ 1.05	4.98 $\pm$ 0.95	$p > 0.05$	4.5 $\pm$ 0.98	3.89 $\pm$ 0.97	$p > 0.05$	$p < 0.05$	$p < 0.05$	3.25 $\pm$ 0.65	1.98 $\pm$ 0.78	$p < 0.05$	$p < 0.05$	$p < 0.05$	0.17 $\pm$ 0.38	0.12 $\pm$ 0.33	$p < 0.05$	$p < 0.05$	$p > 0.05$
Coughing	6.44 $\pm$ 1	6.38 $\pm$ 0.91	$p > 0.05$	5.67 $\pm$ 0.96	5.40 $\pm$ 0.86	$p > 0.05$	$p < 0.05$	$p < 0.05$	4.67 $\pm$ 0.76	2.74 $\pm$ 0.73	$p < 0.05$	$p < 0.05$	$p < 0.05$	0.19 $\pm$ 0.47	0.15 $\pm$ 0.42	$p < 0.05$	$p < 0.05$	$p > 0.05$
Turning over	7.14 $\pm$ 1.05	7.11 $\pm$ 0.83	$p > 0.05$	6.78 $\pm$ 0.99	6.76 $\pm$ 1.05	$p > 0.05$	$p < 0.05$	$p < 0.05$	5.86 $\pm$ 0.83	3.07 $\pm$ 0.71	$p < 0.05$	$p < 0.05$	$p < 0.05$	0.28 $\pm$ 0.57	0.17 $\pm$ 0.49	$p < 0.05$	$p < 0.05$	$p > 0.05$

DISCUSSION:

A total of 92 patients were enrolled in this prospective comparative study, out of which 78 patients were duly followed-up. The injection group had 42 patients while the ibuprofen group had 36 patients at the end of the study. We aimed at analysing the pain relief obtained in cases of isolated single rib fractures, using a novel method of injecting a combination of 1 ml 0.5% bupivacaine hydrochloride and 1 ml triamcinolone (40mg) directly at the site of the fracture. This was compared with the otherwise commonly implemented management protocol of oral analgesics in the form of tablet ibuprofen 400mg^[12] with an option of 400mg SOS once day. The demographic parameters of both the groups were comparable upon enrolment (Table 1).

In totality, the results showed significantly higher pain relief in injection group at rest, coughing, deep inspiration and sleeping on the affected side even at short-term follow-up (2 weeks). This facilitated earlier recruitment to ventilation exercises which subsequently decreases the possibility of pulmonary complications. The overall quality of life was improved in these patients due to early return to daily activities, and decreased sleep disturbance which was on par with

other methods of regional analgesia^[12,13]. Most importantly, the duration for fracture healing remained unaffected. The distinguishing aspect of this study was testing of pain intensity not just on rest, but also during active, commonly pain-inducing activities in such kinds of injuries, thus accurately assessing its effect on the overall resultant disability. The pain of rib fracture has been shown to peak at 2-4 weeks and subside thereafter, due to natural union of the fragments and oral analgesic consumption^[14]. Hence, the positive short-term results of this method provide a potential breakthrough in pain management of such injuries. It also precludes the need for a specialist, of systemic side-effects or risk of injury to vital structures as is the case with other forms of regional analgesia such as intercostal nerve block, paravertebral block, epidural analgesia and intrapleural block.

However, the small sample size and restricted catchment area for sample collection were the limitations of our study and we suggest further studies with more demographic variability to establish this procedure as an efficient intervention for pain relief in solitary rib fractures and to assess the local and systemic implications of this therapy, if any.

CONCLUSION:

This novel method of locally injecting a combination of 1 ml 0.5% bupivacaine hydrochloride and 1 ml triamcinolone (40mg) at the site of the fracture once every 2 weeks, from presentation to 4 weeks post-injury, is potentially a safe and an efficient method for short-term as well as continued pain relief in patients with solitary, post-traumatic, acute rib fracture. The pain relief was obtained not only at rest, but extended to coughing, deep breathing and turning over. Further studies are required to assess its efficacy in a more varied demographic pool and in combination with oral analgesics.

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