EFFECT OF INTERCOSTAL NERVE BLOCK AND NON-OPIOID DRUG THERAPY IN RIB FRACTURES: A COMPARATIVE OBSERVATIONAL STUDY

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ABSTRACT

BACKGROUND

Multiple fracture ribs following trauma is one of the common problems managed in a surgical casualty. Pain in rib fracture can be managed by different modes of analgesia. Superior analgesia provides superior improvement in lung compliance after rib fracture thereby reducing morbidity and mortality due to secondary pulmonary complications.

METHODS

Patients with evidence of rib fracture who received intercostal nerve block along with non-opioid drugs were grouped into Group A and those who received non-opioid drugs alone were grouped into Group B. The effect on pain score and lung compliance were measured by using Visual Analogue Scale and a respirometer respectively before therapy, soon after therapy, 12 hours after therapy and 24 hours later (in both groups).

RESULTS

In patients who received both intercostal nerve block as well as non-opioid therapy, the pain score decreased, and respirometer score increased progressively. In patients who received non-opioid therapy alone, only a mild decrease in pain score and mild increase in respirometer score till 12 hours and even worsening of mean score 24 hours post therapy were noted. Also, the incidence of development of pulmonary complications of rib fractures was significantly low in the former group compared to the latter.

CONCLUSIONS

Intercostal nerve block along with non-opioid drugs provide superior pain relief compared to that provided by non-opioid drugs alone in patients suffering from rib fracture. Lung compliance was better and complications lesser in patients who received intercostal nerve block.

KEYWORDS

Rib Fracture, Effective Analgesia, Intercostal Nerve Block, Secondary Complications.

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BACKGROUND

This study is expected to throw light on the probable superiority of intercostal nerve block in providing better analgesic effect, reducing the incidence of pulmonary complications and providing better improvement in the quality of post traumatic life in comparison to non-opioid drugs in patients suffering from rib fracture.

Pain is a primary risk factor for morbidity and mortality among patients who present with chest trauma[1] and it causes patients to typically alter ventilation (to avoid exacerbation of that pain) by restricting breathing and decreasing tidal volume.[2] This impedes chest physiotherapy and pulmonary toilet, often causing ineffective coughing, which results in insufficient clearing of airway secretions and retention of sputum.[3] This in turn leads to atelectasis (reducing lung compliance and functional residual capacity, resulting in a mismatch of ventilation and perfusion) and parenchymal lung infection.[4] This leads to higher risk for pulmonary complications as secondary pneumonia with pulmonary consolidation, in turn leading to respiratory failure and the need for intubation and ventilator support. The ultimate consequence of these secondary complications is a high risk of mortality.

If the patient's pain is not exacerbated with normal ventilation and coughing (thus an adequate tidal volume is maintained and coughing can occur without exacerbation of symptoms), the risk of pulmonary complications (e.g. atelectasis, pneumonia, and the need for mechanical ventilation) is reduced.[5] For this reason, effective pain

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management is critical to restoration of pulmonary function and the avoidance of morbidity and mortality.

Treatment options include systemic and local analgesic agents delivered by various methods. As intercostal nerve block appeared to be both a simple and an effective option, the effect of this therapy is studied here with regard to pain relief and reduction in pulmonary complications.

METHODS

This study was conducted in the surgical wards and surgical casualty of General Surgery department, Government Medical College, Thrissur, Kerala. Every patient above 13 years of age who had given informed written consent, with evidence of rib fracture during the study period of March 2016 to March 2017 were participants of the study. Patients who were not willing to participate in the study or having history suggestive of coronary artery disease/ rheumatic heart disease/ cardiac arrhythmias/chronic obstructive pulmonary disease/ bronchial asthma/ pulmonary tuberculosis/ interstitial lung disease/ bleeding dyscrasias/ epilepsy/cerebrovascular attack were excluded from the study.

A total number of 68 patients were included in the study. They were grouped into two equal groups - Group A and Group B, with 34 patients in each group. Patients who received intercostal nerve block along with non-opioid drugs (for example, oral or parenteral NSAIDs) were grouped into Group A and those who received non-opioid drugs alone were grouped into Group B. Intercostal nerve block was performed as a minor procedure at the patient's bed side. The patient was positioned in the lateral or prone position. A 22-gauge needle on a 10 ml syringe was inserted at the inferior border of the fractured rib about 6-8 cm from the vertebral spine. 3-5 ml of 0.25-0.5% bupivacaine was injected at the site. Further 1-2 ml of solution was injected while withdrawing the needle.

The effect on pain score and lung compliance was measured by using Visual Analogue Scale and a respirometer respectively soon after, 12 hours after & 24 hours after the therapy. A comparative observational study of the results obtained was done.

Method used for calculation of sample size was Independent sample 't' test.

$$\text{Sample Size of each group, } n = \frac{(Z\alpha + Z\beta)^2 SD^2 \times 2}{d^2}$$

where $Z\alpha$ = is the Z value at an α error (at an α error of 5%, $Z\alpha$=1.96)

$Z\beta$ = is the Z value at a β error (at a β error of 20%, $Z\beta$=0.842)

SD = average standard deviation of pain measured by Visual Analogue Scale in cases & controls

$$= \frac{S_1 + S_2}{2}$$

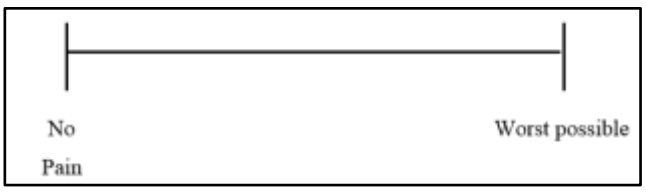
(SD_1 & SD_2 are the standard deviations of Visual Analogue Scale in cases & controls respectively)

d = difference of mean Visual Analogue Scales in cases & controls

By using the values of SD_1 & SD_2 obtained from a similar study,[6] the sample size of each group has been calculated as 24.

Data was analysed using MS Excel. Quantitative variable was expressed using mean and standard deviation. Qualitative variable was expressed using proportion and frequency. The results of the study were compared using two tools: Visual Analogue Scale and the respirometer.

Visual Analogue Scale



Respirometer Score

Balls Moving	Score
Red ball does not move	0
Red ball moves, but does not hit roof	1
Red ball hits the roof	2
Yellow ball moves, but does not hit roof	3
Yellow ball hits the roof	4
Blue ball moves, but does not hit roof	5
Blue ball hits the roof	6

RESULTS

A total of 68 patients suffering from rib fractures participated in the study during the period of 1 year. Of these 8 were females and 60 were males. 2 patients were less than 25 years of age, 34 were aged between 25 and 50 years and the rest 32 were older than 50 years.

All 68 patients had complaints of chest pain while 29 of them also had breathlessness and 30 also had cough. The high pulse rate of patients treated with intercostal nerve block along with non-opioid drugs(hereafter referred to as dual therapy) was remarkably relieved while patients treated with non-opioid therapy alone(hereafter referred to as monotherapy) showed only momentary fluctuations. The same pattern was observed in the relief of hypotension. High respiratory rate of patients who received dual therapy had settled down up to 12 hours after therapy while those who received monotherapy had mild relief and also progressive worsening of tachypnoea in a few. The oxygen saturation showed significant improvement soon after and 12 hours after dual therapy but was not significant after 24 hours. The abnormal shape, abnormal chest movements, usage of accessory muscles of respiration, presence of wheeze/ stridor, intercostal suctioning and unequal air entry were significantly reduced soon after therapy and extended up to 24 hours later in patients who received dual therapy. Localised chest tenderness was also found to be significantly relieved soon after to 12 hours after therapy in patients who received dual therapy compared to those who received monotherapy. But this effect failed to show much significance at the end of 24 hours.

In patients who received dual therapy, pain score decreased progressively over a period of 12 hours (with a mean VAS of 8.3 before therapy decreasing to 1.3 soon after therapy and to 0.12 after 12 hours) and failed to reach pre procedure levels even after 24 hours (VAS after 24 hours

was 3.6 compared to 8.3 at pre procedure period) but in patients who received monotherapy, there was only mild decrease in the score till 12 hours (with a mean VAS of 7.6 before therapy decreasing to 4.7 soon after therapy and increasing to 6.8 after 12 hours) and even worsening of mean score 24 hours post therapy (VAS after 24 hours was 7.9 compared to 7.6 before therapy). In patients who received dual therapy, the respirometer score increased progressively over a period of 12 hours (from 0.76 before therapy to 5.5 soon after therapy to 5.97 after 12 hours) and decreased mildly after 24 hours (4.44) but never reached pre procedure levels (0.76). In patients who received monotherapy, there was only mild increase in the score till 12 hours (from 1.47 before therapy to 3.47 soon after therapy to 2.02 after 12 hours) and even decrease in mean score 24 hours post therapy (1.17 compared to 1.47). The incidence of development of pulmonary complications of rib fractures (e.g. Surgical emphysema, pneumothorax, haemothorax) was significantly low (0) in patients who received dual therapy compared to 6 patients who developed complications after receiving monotherapy (p=0.0109).

	Before Therapy	Soon After Therapy	12 Hours After Therapy	24 Hours After Therapy
Group A	8.3	1.3	0.12	3.6
Group B	7.6	4.7	6.8	7.9
Standard Deviation				
Group A	0.86	0.86	0.33	0.8
Group B	0.88	0.89	0.82	0.59

Table 1. Pain Score by Visual Analogue Scale (Average 1-10)

	Before Therapy	Soon After Therapy	12 Hours After Therapy	24 Hours After Therapy
Group A	0.76	5.5	5.97	4.44
Group B	1.47	3.47	2.02	1.17
Standard Deviation				
Group A	0.81	0.56	0.17	0.82
Group B	0.66	0.74	0.45	0.57

Table 2. Average Respirometer Score

	Complications Developed	Complications Not Developed
Intercostal Nerve Block Received	0	34
Intercostal Nerve Block Not Received	6	28

Table 3. Development of Complications

p= 0.0109

DISCUSSION

In rib fractures, the characteristics of the injuries are diverse, and the degree of damage is inconsistent. Although the mean number of fractures is typically 4-6 ribs,[7,8,9] the range is broad. Additionally, forces large enough to break ribs frequently result in associated injuries such as pulmonary contusion and flail chest.[8,10]

Effective pain management is critical to restoration of pulmonary function and the avoidance of morbidity and mortality due to rib tractures.[11] A variety of modes of analgesia exist; some are systemic (e.g., oral and intravenous anti-inflammatory agents, intravenous opioids, and narcotic dermal patches) while others are local agents (e.g., intercostal nerve blocks, intrapleural nerve blocks, thoracic paravertebral blocks, and TEA). Less common modes of therapy have been attempted, including intrathecal opioids, narcotic dermal patches, epidural steroid injections, and transcutaneous electrical nerve stimulation.

Regional analgesia is often supplemented with a small dose of either NSAIDs or opioids and pain reduction is typically strong and immediate.[12] There is little sedation, so evaluation of head and abdominal injuries is easier. A major disadvantage is the technical complexity of these procedures, leading to occasional errors in the administering of the treatment. They can also be painful while the needle is entering (or catheter is being introduced), toxicity is a possibility, and the patients require more intensive monitoring and care by the physicians and nurses. In our study we have compared the analgesic effect of two modes of analgesia used for relieving pain caused by rib fractures, namely oral non opioid drug therapy & a combination of the same oral drug therapy supplemented with intercostal nerve block using bupivacaine as the anaesthetic agent. Our study has not only proved that a combination of regional analgesia with oral analgesia provides better pain relief than oral analgesia alone (indicated by a mean VAS of 8.3 decreasing to a maximum of 3.6 in patients receiving dual therapy compared to a mean VAS of 7.6 decreasing to a maximum of 6.8 in patients receiving monotherapy), but also it shows a strong association of markedly reduced number of complications (0 compared to 6) associated with rib fractures, following the superior analgesic effect as per the data tabulated above.

The technical methodology of ICNB was reported by Moore and Bridenbaugh (1962); it includes using medical imaging techniques to find the intercostal nerve targeted for blocking on the basis of the pain location and then injecting a local anaesthetic into the target area.[13] The advantages of ICNB are as follows: relatively simple for use, no neurological complications due to nausea, vomiting, dizziness, or bleeding and no complications from possible misjudgement observed in other measures such as thoracic epidural injection.

The disadvantages include claims that it must be repeated every 6-8 hours because its effects do not last long (Pederson et al., 1983)[14] and the possibility of complications such as pneumothorax or haemothorax. Previous studies in literature have also concluded that utilization of ICNB significantly improved pulmonary function, pain control, and shortens length of hospital stay for patients with rib fractures.[15] Osinowo OA[16] concluded that significant increases in SaO_2 and PEFR occur after ICNB with 0.5% bupivacaine, which also provides sustained analgesia, leading to improvement in respiratory mechanics. Haenel JB et al confirmed that an indwelling intercostal catheter provides a continuous nerve block resulting in a simple, safe

procedure that can ameliorate the pain and splinting associated with multiple rib fractures.[17]

Limitations of the Study

The study does not relate the efficacy of therapy to the number of ribs fractured or the site or the side of performing intercostal nerve block. Patients who received oral and parenteral non opioid drugs were grouped together.

CONCLUSIONS

From our study, we obtained mean VAS values showing a steeply decreasing trend in course of time in patients receiving dual therapy whereas patients receiving monotherapy expressed VAS values showing only mild decrease and ultimately increasing to values more than the pre therapy values. Hence, we were able to conclude that intercostal nerve block along with non-opioid drugs provide superior pain relief compared to that provided by non-opioid drugs alone in patients suffering from rib fracture. We also obtained respirometer scores (indicating lung compliance) showing an improving trend in patients receiving dual therapy (and in turn reducing pulmonary complications) compared to a transiently improving and later worsening trend in patients receiving monotherapy. This concludes that the superior pain relief provided by intercostal nerve block along with non-opioid drugs compared to that provided by non-opioid drugs alone, improves the lung compliance significantly enough to reduce pulmonary complications in patients suffering from rib fracture.

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