IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 3 Ver.10 March. (2018), PP 68-74
www.iosrjournals.org

Intercostal nerve block proved superior to systemic analgesia in the control of chest pain in patients with traumatic rib fractures

EE Ekpe[1], OO Bassey[2], AU Etiuma[2], MC Ikpe[3]
[1]*Cardiothoracic Surgery Unit, Department of Surgery, University of Uyo Teaching Hospital, Uyo, Akwa Ibom State, Nigeria*
[2]*Cardiothoracic Surgery Unit, Department of Surgery, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria*
[3]*Department of Radiology, University of Uyo Teaching Hospital, Uyo, Akwa Ibom State, Nigeria*
Correspondence: Dr. Eyo E. Ekpe

Abstract: ***Objective:*** *This study was carried out to compare the efficacy of intravenous tramadol injection and intercostal nerve block with 0.5% bupivacaine injection for control of chest pain in multiple rib fractures.* ***Methods:*** *Prospective randomized study of intercostal nerve block (ICNB) with 0.5% bupivacaine group (n=30) and the intravenous tramadol (IVT) injection group (n=34).* ***Results:*** *There were 64 adult patients who were studied with multiple rib fractures caused by blunt chest trauma. Before analgesia, 33.3% and 66.7% of patients in the ICNB group rated their pain as moderate and severe respectively while 29.4% and 70.6% of patients in the IVT group rated their pain as moderate and severe respectively (p= 0.917). However at one hour post commencement of analgesic, 13.3%, 70%, 16,7%, and 0% rated their chest pain as no pain, mild pain, moderate pain and severe pain respectively among the ICNB group while in the IVT group the respective figures were 0%, 23.5%, 64.7% and 11.8% (p value <0,0001); and at 24hours post commencement of analgesic the equivalent figures were 0%, 90%, 10% and 0% in ICNB group against 0%, 76.6%, 23.4% and 0% in the IVT group (p=0.002). Comparison of efficacy based on improvement in pain scores among the two groups of intervention showed that ICNB was superior to IVT at both the one hour and 24 hours re-assessment periods.* ***Conclusion:*** *This study shows that ICNB is superior to IVT in chest pain control in multiple rib fractures of blunt chest trauma.*

Keywords: *Blunt chest injury; Intercostal nerve block; Multiple rib fractures; Pain control; Systemic analgesia.*

Date of Submission: 03-03-2018 Date of acceptance: 23-03-2018

I. Introduction

Thoracic trauma leading to multiple fractured ribs (MFR) remains common.[1] While the chest pain associated with a single rib fracture is relatively easy to control, the significant chest pain of multiple rib fractures can be difficult to manage and can lead to decreased pulmonary function, increased hospital stay, and increased health care expenditures.[2] Patients with traumatic rib fractures often present with varying degrees of chest pain, which in turn leads to impairment of pulmonary mechanics, retention of tracheo-bronchial secretions, and atelectasis.[3] Multiple rib fractures cause severe chest pain that can seriously compromise respiratory mechanics and exacerbate underlying lung injury and pre-existing respiratory disease, predisposing to respiratory failure.[4] Good analgesia may help to improve the patient's respiratory mechanics, avoid intubation of the trachea for mechanical ventilation and therefore may dramatically alter the course of recovery.[1] The cornerstone of chest pain management is early institution of effective pain relief.[4]

Analgesia could be provided using systemic opioids, transcutaneous electrical nerve stimulation or non-steroidal anti-inflammatory drugs. Alternatively, regional analgesic techniques such as intercostal nerve block, epidural analgesia, intrathecal opioids, intra-pleural analgesia and thoracic paravertebral block have been used effectively. Although invasive, in general, regional blocks tend to be more effective than systemic opioids, and produce less systemic side effects.[4] Studies have shown that injection into one intercostal groove blocks the intercostal nerve of that groove, and at least the one above and below it because of sub-pleural tracking.[3] Immediate pain relief after intercostal nerve block and improvement in pulmonary mechanics have been demonstrated in several reports.[3,5]

This study was aimed at prospectively evaluating the efficacy of systemic and regional analgesia for chest pain control in multiple rib fractures in adult blunt chest trauma patients in our Centre.

II. Material And Methods

Approval to embark on this study was sought and obtained from the Hospital Research Ethical Committee and was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was duly obtained from the patients after adequate explanation. The study/data collection took place from November 2013 to October 2014.

On presentation, the successive patients were clinically evaluated and resuscitated. At this point patients with clinically discovered exclusion criterion/criteria were excluded while those without were further evaluated with urgent chest radiogram. Following urgent postero-lateral and oblique chest radiographs to confirm the clinical suspicion of rib fracture(s) in the appropriate patients with blunt chest injury who met all the inclusion criteria for the study, the radiographic films were interpreted to ascertain the number and order of rib fracture(s). The chest x-ray also enabled the calculation of abbreviated thoracic injury severity score, and to decide patients' eligibility for inclusion in the study.

Successive patients who met the inclusion criteria were randomized into the regional analgesia and systemic analgesia arms of the study using computer generated randomization table from WINPEPI software: intercostal nerve block (ICNB) with 0.5% plain bupivacaine group and the slow intravenous tramadol (IVT) injection group. With the help of WINPEPI computer software on random allocation, the 64 patients were allocated into the two study groups based on the serial number given at enrolment. The randomization table placed 30 subjects in group 'A' (ICNB) and 34 in group 'B' (IVT). The randomization was such that it was not possible to know the group for a particular patient beforehand or to influence the allocation.

Those included were: 1. All adult blunt chest trauma patients with unilateral multiple rib fractures. 2. All adult blunt chest trauma patients with unilateral multiple rib fractures with no associated major intrathoracic or extrathoracic injury such as head injury, abdominal injury or skeletal injury; while those excluded were: patients under 16 years of age, refusal to give consent, history of sensitivity to either bupivacaine or tramadol, or contraindication to adrenaline, associated major injury needing surgical operation or affecting consciousness level,. pre-existing pulmonary disease, and bilateral rib fractures. Other contraindications were patients who had haemothorax or patients with greater than minor (15%) traumatic pneumothorax which on its own can adversely affect pulmonary function, patients with only one rib fracture, and patients with segmental rib fractures (flail chest).

Baseline pain score on the 4-point verbal rating scale was assessed and recorded in the respective patient's profoma. For the intercostal nerve block group, 2 ml of 0.5% plain bupivacaine injection (1-2mg/kg body weight) pre-mixed with 1:20000 dilution of adrenaline was used to infiltrate each intercostal nerve associated with all the fractured ribs and one rib superior and inferior to the fractured ribs. For patients on the intravenous tramadol (IVT) group, 100mg (1.5-2.0mg/kg body weight) of tramadol hydrochloride injection was administered intravenously slowly via an in-dwelling venous cannula every 8 hours for 24 hours. All the patients were re-assessed at one hour and 24 hours after commencement of analgesic, and pain score evaluation repeated as above and recorded into the individual's profoma. Patients who had breakthrough pain and complained of severe pain were given 30mg of pentazocine injection intravenously.

Evaluation of response and outcome measures

The following outcome measures were compared before and after analgesia and among the two groups: mean age of the patients in the two arms of the study, sex of the patients in the two arms of the study, mean abbreviated thoracic trauma severity scores of the two groups, mean number of rib fractures among the two groups determined on chest radiogram, pain scores of the two groups before, one hour and 24 hours after commencement of analgesia, pulmonary complication rate among the two groups, mortality rate among the two groups, mean need for rescue analgesia (pentazocine injection) among the two groups, and complication(s) (if any) of the analgesic technique of the two groups.

Statistical analyses

The data were subjected to statistical analysis using STATA Version 10 software (Stata Corp, College Station, Texas). The t-test was used for continuous variables and the Chi-squared or Fisher's exact tests, when appropriate, for comparison of proportions. Responses between the two groups were compared at each evaluation (before, one hour and 24 hours after commencement of analgesia) using the Chi-squared test. All statistical comparisons between regional and systemic analgesia were two-sided and carried out at the 0.05 significance level.

III. Results

There were 64 adult patients who were studied with multiple rib fractures caused by blunt chest trauma distributed as 30 in the ICNB group and 34 in the IVT group. There were 54 (84.4%) men randomized into the two groups 26 (ICNB) and 28 (IVT), and 10 (15.6%) women randomized as four (ICNB) and six (IVT) respectively. Young adult males and middle age males were very culpable accounting for up to 94.4% (28 in

ICNB and 31 in IVT group) while elderly male accounted for only 5.6% (two in ICNB and three in IVT). However among the female adult victims with multiple rib fractures, the age distribution was even from young adult to elderly age group and also evenly distributed among the two interventional groups (table 1). There were no statistically significant differences in age and sex among the two study groups. Table 1 also shows the occupations of the victims of traumatic multiple rib fractures in this study; commercial motorcyclists (including tricycles), all males, accounted for 63.3% of ICNB group and 61.8% of IVT group patients in the study. There were five commercial drivers, all males making up 6.7% ICNB and 8.8%IVT. The other occupations in the study included civil service, schooling, trading, technical work, etc, which were few and comparable among both genders and study groups. Table 1 shows that the age distribution and the occupations of the adult patients with blunt chest trauma and multiple rib fractures were comparable between the two arms of the study with no statistically significant difference.

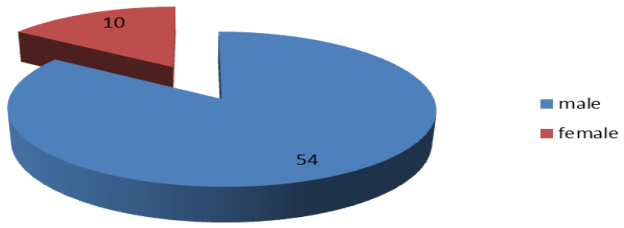
Table 2 shows the characteristics of blunt chest injuries encountered in the study. According to mechanism of the blunt chest injury, motorcycle and tricycle accidents significantly accounted for the cause of multiple rib fractures in 50 (78.1%) of the patients. The other causes of multiple rib fractures encountered in the study were motor traffic accident in nine (14.1%), fall from height in two (3.1%), and fall into gutter, fall in bathtub, and hit by a falling tree branch in the remaining three (4.7%) of patients. The various causes were evenly distributed in the two arms of the study. Table 2 also shows that the numbers of ribs fractured in the 64 patients in the two arms of the study were same and ranged from two to six (mean=3). Also the types of analgesic used in the study were ICNB 46.9% vs IVT 53.1%.

Table 3 shows that before the institution of analgesic, 33.3% and 66.7% of patients in the ICNB group rated their chest pain as moderate and severe respectively. The equivalent figures in the IVT group were 31.3% and 67.7%. There was no statistical difference between the two groups. By one hour post commencement of analgesic in the ICNB group, 13.3% had no chest pain, 70.0% had mild pain, 16.7% had moderate pain while no patient still had severe chest pain. The equivalent figures in the IVT group were 0.0%, 23.5%, 64.7% and 11.8% respectively. The improvement in pain was statistically significantly different between the two groups ($p<0.0001$). Again at 24 hours post commencement of analgesic; in the ICNB group, 90.0% reported mild chest pain and 10.0% reported moderate chest pain, while in the IVT group 76.6% reported mild chest pain and 23.4% reported moderate chest. There was an inter-group statistical difference with $p=0.002$.

Table1: The socio-demographic characteristics of adult patients with blunt chest trauma and multiple rib fractures according to mode of pain control

Socio	**IVT**	**ICNB**	**Total**
Demographic	**n=34**	**n=30**	**N=64(%)**
Age group (yrs)			
16-30	12(18.8)	10(15.6)	22(34.4)
30-50	11(17.2)	10(15.6)	21(32.8)
50-60	8(12.5)	8(12.5)	16(25.0)
Above 60	3(4.7)	2(3.1)	5(7.8)
Mean	41.4	42.2	41.5
Occupation			
Commercial cyclists (including kekenapep)	21(32.8)	19(29.7)	40(62.5)
Commercial drivers	3(4.7)	2(3.1)	5(7.8)
Civil servants	5(7.8)	3(4.7)	8(12.5)
Schooling	3(4.7)	4(6.2)	7(10.9)
Others	2(3.1)	2(3.1)	4(6.3)
TOTAL	34(53.1)	30(46.9)	64(100)

Figure 1: Sex distribution of the patients with blunt chest injury and multiple rib fractures



Legend:
Male = 54 (84.4%)
Female = 10 (15.6%)

Table 2: Types of injury of the adult patients with chest trauma according to mode of pain control

Variables	**IVT n=34**	**ICNB n=30**	**Total N=64**	**Statistical index**
Mechanism of injury				
Motor cycle (including	26 (40.6)	24(37.5)	50 (78.1)	P value=0.628^{+}
Tricycle)	5 (7.8)	4 (6.2)	9 (14.1)	
	1 (1.6)	1 (1.6)	2 (3.1)	
Motor traffic accident	2 (3.1)	1 (1.6)	3 (4.7)	
Fall from height				
Others	7 (10.9)	6 (9.4)	13 (20.3)	
No of ribs fractured	13 (20.3)	12 (18.8)	25 (39.1)	P value=0.979^{+}
Two	8 (12.5)	8 (12.5)	16 (25.0)	
Three	5 (7.8)	4 (6.2)	9 (14.1)	
Four	1 (1.6)	0 (0.0)	1 (1.6)	
Five				
Six				
TOTAL	34(53.1)	30(46.9)	64(100)	

+Fischer's exact test not statistically significant

Table 3: Chest pain score of patients on ICNB and IVT at different periods of analgesia

Chest pain score (4-point VRS)	**ICNB n=30 (%)**	**IVT n=34 (%)**	**Total n=64 (%)**	**Statistical indices**
Before analgesia				
No pain (0)	0 (0)	0 (0)	0 (0)	
Mild (1)	0 (0)	0 (0)	0 (0)	P value = 0.8900
Moderate (2)	10 (33.3)	10 (29.4)	20 (31.3)	
Severe (3)	20 (66.7)	24 (70.6)	44 (68.7)	
1 hour into analgesia				
No pain (0)	4 (13.3)	0 (0.0)	4 (6.3)	
Mild (1)	21 (70.0)	8 (23.5)	29 (45.3)	Pvalue<0.0001^{+*}
Moderate (2)	5 (16.7)	22 (64.7)	27 (42.2)	
Severe (3)	0 (0.0)	4 (11.8)	4 (6.3)	
24 hours into analgesia				

No pain (0)	0 (0.0)	0 (0.0)	0 (0.0)	
Mild (1)	27 (90.0)	22 (64.7)	49 (76.6)	P value=0.02^{+}
Moderate (2)	3 (10.0)	12 (35.3)	15 (23.4)	
Severe (3)	0 (0.0)	0 (0.0)	0 (0.0)	

IV. Discussion

Over the 12 months study period there were a total of 2118 cases of trauma, and 205 cases of chest trauma. In this study chest trauma accounted for 9.7% of all injuries. This was slightly lower than another study with thoracic traumas comprising 10–15% of all traumas and being the direct causes of death in 25% of all fatalities due to trauma.[6] However only 64 patients with chest trauma met the inclusion criteria for the study. This study has shown that chest trauma constitutes 9.7% of trauma cases in the centre, with 82 cases of rib fractures constituting 40% of chest trauma. This is in agreement with the study of Liman et al which reported rib fractures as the most common pathologies associated with chest trauma.[7] However the 64 patients studied constituted only 31% of chest injury since some cases of rib fractures were excluded from the study. Expectedly there were more men than women (84.4% vs 15.6%) giving male female ratio of 6.4:1. This is because 70.3% of the patients were engaged in commercial transportation (motor cycles and tricycles) a predominantly male occupation. Similar male preponderance has been found in other studies because of motor vehicle accidents.[3,8] Although in other series analyzing chest trauma and rib fractures males also predominate partly because of workplace injuries, involvement in crimes and assaults.[3,9] Therefore commercial transportation particularly with the use of motorcycles seems to be an important risk factor for chest trauma in particular and all types of trauma in general. In this study this was statistically significant when compared with all other occupations put together ($p<0.0001$). This is more so where and when motorcycles are used as a means of commercial transportation in the city centre with high volumes of traffic. As part of the strategy to curb the prevalence of motorcycle and motor vehicle accidents, outright legislation against and restriction on use of motorcycles in the city centres, which have been operational in some states in Nigeria, would help tremendously. Also training and retraining of all motorcyclists on safe riding should be implemented. For the same reasons alluded to above young adults and middle age men formed the majority (92.2%) of patients with multiple rib fractures as a result of blunt chest trauma in this study (mean age = 41.1 years) against the 7.8% elderly people. In the Sirmah et al study, the mean age of the patients was 43 years.[9] The other mechanism of chest trauma and multiple rib fractures were few and included fall from height, fall in bath-tub, assault, and tripped and fall. Women also bear the brunch of commercial motorcycle when they are involved in motorcycle accident as either passengers or pedestrians.

Studies have shown that plain chest radiographs have sensitivity of about 12-50% and may not identify all the rib fractures in blunt chest trauma and therefore have suggested the use of chest computerized tomography and ultrasonography (USG) to diagnose all rib fractures.[10,11] However, the present study was limited to chest radiographs for confirmation of rib fractures. USG was more sensitive in the detection of rib fractures including the chondral rib fractures compared with chest X-rays that 40% of patients with minor blunt chest trauma had undetected rib fractures on chest X-rays, which was revealed with USG, and its sensitivity rate reaches up to 78% compared with 12% detected on chest X-rays.[11] Plain chest radiographs were used in the present study to show that the 64 patients with multiple rib fractures studied had two to six unilateral rib fractures with a mean of three rib fractures. This is understandable since the mechanism of injury in this study was motorcycle accident in up to 78%. In motorcycle and pedestrian accidents, the body of the victim is not protected and comes in direct impact whereas victims in motor vehicular accident have their body protected by the housing of the vehicle. Inter-therapy group comparison of age, sex, occupation, mechanism of injury and number of rib fracture did not show any statistical difference.

Thirty four (53.1%) patients were administered intravenous tramadol while the remaining 30 (46.9%) were managed with intercostals nerve block. Before commencement of analgesia, equivalent number of patients in the ICNB and IVT groups rated their chest pain as severe (66.7% vs 70.6%) and moderate (33.3% vs 29.4%) respectively while no patient in the two groups had either mild or no chest pain. However at one hour post commencement of analgesic, after first dose of analgesic four (13.3%) patients reported zero chest pain and none had severe pain in the ICNB group. Comparable figures in the IVT group were none for zero chest pain and four (11.8%) for severe pain, By the same one hour re-assessment, in the ICNB group, 70.0% had mild pain while 16.7% had moderate pain. The equivalent figures in the IVT group were 23.5% and 64.7% respectively. There was statistically significant difference between the two groups ($p<0.0001$). Summary of comparison at one hour shows superiority of ICNB over IVT in controlling chest pain in multiple rib fractured patients. Gilart et al noted that pain relief in multiple rib fractures patients is transcendental and it allows for proper ventilation, effective cough and adequate respiratory physiotherapy.[12] Intravenous use of non-steroid and non-opiate anti-inflammatory drugs is quite widespread, although their side-effects are their main drawback. The local and

regional techniques which include intercostal nerve block, epidural analgesics vs. opiates or a combination of both, thoracic paravertebral block and, much less frequently, intrathecal opioids are some available options.[12] Tramadol is of advantage here because it does not cause severe respiratory depression associated with narcotics or gastritis associated with non-steroidal anti-inflammatory drugs and is useful for moderate to severe pain.[13] Each one has its advantages and disadvantages. The criteria for selecting the most effective technique therefore include identifying patients at risk of development of respiratory morbidity due to chest pain from multiple rib fractures of blunt chest trauma and checking the safety and feasibility of the interventional technique in the treatment centre.[14]

Although invasive, in general, regional blocks tend to be more effective than systemic opioids, and produce less systemic side effects.[4] Evaluation of the patients' pain status gave credence to pain control following the commencement of analgesics.

At 24 hours re-assessment period, 90% of patients in the reported mild pain while the remaining 10% reported moderate pain in the ICNB group. The equivalent figures in IVT group were 64.7% and 35.3% respectively. The difference was also statistically significant (p=0.002). Although there was no patient who was completely free from chest pain at 24 hours, there was also no patient with severe chest pain. This has corroborated the fact that both IVT injection and ICNB using 0.5% bupivacaine (+ adrenaline) injection can attenuate moderate to severe chest pain of multiple rib fractures.[3,13] Comparison of efficacy based on reduction in pain scores among the two groups of intervention also showed that ICNB was more effective than IVT at both the one hour and 24 hours re-assessment periods. From pre-intervention in both groups through one hour intra-intervention to 24 hours post intervention respectively. This is in support with findings from similar studies in other parts of the world.[4,12,14,15] Therefore after identifying patients at risk of development of respiratory morbidity due to chest pain from multiple rib fractures of blunt chest trauma and checking the safety and feasibility of the interventional techniques in the treatment centre, this study advocates preference for ICNB over IVT. Bupivacaine is preferred over lidocaine here because the former is long acting with duration of action between eight to 16 hours.[13] Osinowo, et al used bupivacaine in a similar study.[3] Addition of adrenaline serves two purposes; prolongation of duration of action and delay and limitation of systemic absorption thereby avoiding toxicity.[3] Lidocaine is commonly used when analgesia is needed for shorter period of time (about two hours).

Inter-group comparison shows similarity in the pre-therapy severity of chest pain felt by patients in the two intervention groups (table 3). Comparing the two modes of analgesia at 24 hours shows that both were able to mitigate severe chest pain in patients with traumatic multiple rib fractures, but no type of analgesia studied was able to completely eradicate pain at 24th hour point. It therefore means that the zero chest pain that was reported by 13.3% of patients one hour after ICNB could not be sustained at 24th hour because the effect of bupivacaine injection would have worn off before 24 hours. However at 24 hours a single dose of ICNB is probably more effective in controlling chest pain in traumatic multiple rib fractures than three doses of intravenous tramadol injections. This is supported by the fact that at 24 hour point of pain assessment, 27 (90%) and three (10%) of patients in the ICNB group had mild and moderate pain respectively, the respective figures in the IVT group being 22 (64.7%) and 12 (35.3%) patients.

The abbreviated thorax trauma severity score (ATTSS) for rib fractures used in this study was adapted from Pape et al.[16,17] The mean ATTSS in the two groups of patients was not statistically different, and was low because of the stringent selection criteria in the study. Other factors that contribute to ATTSS include bilateral chest involvement, flail segment, lung contusion and pleural involvement,[16,17] which were excluded in this study. Because of the stringent selection criteria adopted in this study, there were no cases of complications either of the blunt chest trauma or of the treatment. There was also no mortality amongst the study population. Rescue analgesia demand was also very negligible; one patient each in the two groups. On the overall, the clinical outcome of treatment in both arms was good. Treatment outcome was however better in the ICNB arm based on better pain control. Various types of chest injury have been treated in the study centre necessitating the different modalities of analgesia to compliment other aspects of treatment.[18-22]

The perceived limitations of this study include sample size of 64 may not have been large enough to allow generalization of the results in the population and the possibility of missing some fractured ribs because of the less than 100% sensitivity of plain radiograph in diagnosing rib fractures in the immediate post-trauma period may have affected the result in the intercostal nerve block arm

V. Conclusion

This study shows that ICNB is superior to IVT in chest pain control in multiple rib fractures of blunt chest trauma and recommends its routine use where the expertise and 0.5% bupivacaine injection are available and there are no contraindications in the patients.

Ethical consideration

This study was approved by the ethical committee of the hospital and was conducted accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Acknowledgements

The authors acknowledge the contributions of the staff of Accident/Emergency Department and Respiratory Laboratory of University of Uyo Teaching Hospital , Uyo , Nigeria.

References

[1]. Ho AM, Karmakar MK, Critchley LA. Acute pain management of patients with multiple fractured ribs: a focus on regional techniques. Curr Opin Crit Care. 2011; **17**: 323-7.
[2]. Bulger EM, Arneson MA, Mock CN, et al. Rib fractures in the elderly. J Trauma. 2000; **48**: 1040–1047.
[3]. Osinowo OA, Zahrani M, Softah A. Effect of intercostal nerve block with 0.5% bupivacaine on peak expiratory flow rate and arterial oxygen saturation in rib fractures. J Trauma 2004; **56**: 345–347.
[4]. Karmakar, MK., Ho, AM. Acute Pain Management of Patients with Multiple Fractured Ribs. J Trauma, Injury, Infection, and Crit Care Issue 2003; **54**: 615-625
[5]. Ekpe EE, Eyo C. Overview of Blunt Chest Injury with Multiple Rib Fractures. BJMMR 2015; **12** (8): 1-15.
[6]. Ziegler DW, Agarwal NN. The morbidity and mortality of rib fractures. J Trauma. 1994; **37**: 975–979.
[7]. Liman ST, Kuzucu A, Tastepe AI, Ulasan GN, Topcu S. Chest injury due to blunt trauma. Eur J Cardiothorac Surg 2003; **23**: 374–378
[8]. Galan G, Peñalver JC, París F, Caffarena JM Jr, Blasco E, Borro JM, García-Zarza A, Padilla J, Pastor J, Tarrazona V. Blunt chest injuries in 1696 patients. Eur J Cardiothorac Surg. 1992; **6** (6): 284-7.
[9]. Sırmalı M, Tu¨ru¨t H, Topc¸u S, Gu¨lhan E, Yazıcı U, Kaya S, Tas¸tepe I. A comprehensive analysis of traumatic rib fractures: morbidity, mortality and management Eur J Cardiothorac Surg 2003; **24**: 133–138
[10]. Livingston DH, Shogan B, John P, Lavery RF. CT diagnosis of Rib fractures and the prediction of acute respiratory failure. J Trauma. 2008; **64** (4): 905-11.
[11]. Karaa M, Dikmena E, Erdalb HH, Simsirb I, Karab SA. Disclosure of unnoticed rib fractures with the use of ultrasonography in minor blunt chest trauma. Eur J Cardiothorac Surg 2003; **24**: 608–613
[12]. Gilart JF, Rodríguez HH, Vallina PM, Balsalobre RM, Suárez PR. Guidelines for the Diagnosis and Treatment of Thoracic Traumatism. Arch Bronconeumol. 2011; **47** (1): 41-49
[13]. Brayfield, A, (ed). "Tramadol Hydrochloride". Martindale: The Complete Drug Reference. Pharmaceutical Press. Retrieved 2 November 2014
[14]. Kamel M, Abdelfatah A. Pain management in blunt thoracic trauma. Ain Shams J Anesthesiol 2010; **3**: 89-96
[15]. Mancini MC, Geibel J. Blunt Chest Trauma. http://emedicine.medscape.com/article/ 428723-overview#a11, Accessed on 2nd November 2014
[16]. Pape HC, Remmers D, Rice J, Ebisch M, Krettek C, Tscherne H. Appraisal of early evaluation of blunt chest trauma: development of a standardized scoring system for initial clinical decision making. J Trauma. 2000; **49** (3): 496–504.
[17]. Aukema TS, Beenen LFM, Hietbrink F, LeenenLPH. Validation of the Thorax Trauma Severity Score for mortality and its value for the development of acute respiratory distress syndrome. Open Access Emerg Med. 2011; **3**; 49–53
[18]. Ekpe EE, Ette VF, Akpan AF. Pattern of cardiothoracic surgical diseases in a new cardiothoracic surgery unit in Nigeria. Nig J Med 2014; **23** (1):77-82
[19]. Ekpe EE, Eyo C. Determinants of Mortality in Chest Trauma Patients. Nig J Surg 2014; **20**: 30-34
[20]. Ekpe EE, Ikpe MC. Extensive interstitial emphysema complicating blunt chest injury. Ibom Med J 2011; **4**: 11-14.
[21]. Ekpe EE, Nottidge TE, Akaiso OE. Cardiothoracic Surgical Emergencies in a Niger Delta Tertiary Health Institution: A 12 Month Appraisal. Ibom Med J 2008; **3** (1): 22-29.
[22]. Ekpe E. E, Eyo C. Effect of Analgesia on the Changes in Respiratory Parameters in Blunt Chest Injury with Multiple Rib Fractures. Ann Afr Med. 2017 Jul-Sep;16(3):120-126.