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Original Research

What is the relationship between the Number of Significant rib fractures and Haemothorax in adults with blunt chest trauma?

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Abstract

Background: The study aimed to determine the correlation between the number of significant rib fractures in patients with blunt chest trauma (BCT) and the amount of haemothorax as recorded by Closed Thoracostomy Tube Drainage (CTTD).

Methodology: This was a cross-sectional study of all patients with significant rib fractures following BCT over a period of two years. "Significant rib fractures" was defined as the fracture of 3 or more ribs with 50% or more displacement of each fractured rib edge. Patients with massive haemothorax, patients with severe neurological, or patients who required emergency thoracotomy were excluded. The diagnosis of rib fracture was made by standard chest radiograph or Chest Tomography Scan. Descriptive analyses were reported as mean and standard deviation (SD) for the variables. Pearson correlation test was conducted to test the relationship between the numbers of fractured ribs with the amount of haemothorax as recorded by CTTD with P-value significant at<0.001.

Result: Sixteen patients who met the criteria were analysed with a mean age of 46.5years±(SD16.47), the mean number of fractured ribs was 4.5±1.37, the mean amount of drained blood was 605.3ml±(SD244.3) and the mean amount of drained blood per the number of each fractured rib was 134.5ml±54.29. The Pearson Correlation test was strongly positive at,r=0.80 with ($P < 0.001$).

Conclusion: In any patient with BCT, and with fractured of 3 or more ribs, there may be the need to institute a CTTD irrespective of whether the chest radiograph or chest computerized scan shows immediate evidence of significant haemothorax.

Keyword; Chest Tube; Haemothorax; Intercostal Vessels; Relationship; Rib fracture

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Introduction

Rib fracture may be accompanied by concomitant injuries such as haemothorax, pneumothorax, subcutaneous emphysema, and pulmonary contusion; and about 58.7% of patients with blunt chest injury have rib fracture. [1,2] The morbidity and mortality may increase as the number of fracture ribs increases. [2-4] Thus, the number of rib fractures could be a strong predictor for developing pleuro-pulmonary complications [5] and rib fractures are strongly correlated with significant morbidity.[6]

One of the important accompaniments of rib fracture that may necessitate the insertion of a chest tube is haemothorax [5], and since as the complications of rib fracture increase, the morbidity increases, it may still be true that with the increasing number of rib fractures, the amount of haemothorax may also increase. Some authorities feel that when three or more rib fractures are present, haemothorax is inevitable, [3,4] and thus the need to drain the haemothorax with a chest tube.

This study aimed to determine the correlation of the number of fractured ribs in a patient with blunt chest trauma and the amount of haemothorax drained on insertion of a chest tube.

Method

This is cross sectional study of patients who sustained rib fracture following blunt chest trauma over a period of two years. The patients included were adult patients with 3 or more fractured ribs with the displacement of each rib edge to about 50% or more, with the patient presenting within 6 hours of injury. Excluded patients were patients with massive haemothorax, patients with an associated blunt abdominal injury, severe neurological and long bone fracture, or patients who required emergency thoracotomy.

Procedure

The diagnosis of rib fracture was made by plain chest radiograph or chest Computerized Tomography Scan. The numbers of displaced and non-displaced rib fractures were noted. A Significant rib fracture was defined as the fracture of 3 or more ribs and each having 50% or more displacement of each fractured rib edge. And displaced rib fracture was defined as a displacement distance at least half of the rib width [5]. The fractured ribs must have 50% displacement, and displaced ribs must be 3 ribs or more for chest tube thoracotomy drainage (CTTD) to be implemented. The chest tubes were inserted without the use of trocars to avoid injury to the lungs and reduce the blood loss. The amount of blood drained via the chest tube was also noted. Data was analysed using the Statistical Package for Social Sciences software (version 21.0). Descriptive statistical was conducted and reported as mean and standard deviation (SD) for variables, and a Pearson correlation test was conducted to test the relationship between the numbers of fractured ribs with the amount of haemothorax drain by the CTTD.

Research Quality and Ethics Statement

The study followed the reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. Ethics Committee review and the corresponding protocol/approval number [UPTH/ADM/90/S. II/VOL. XI/680] was obtained from the University of Port Harcourt teaching hospital research and ethics committee.

Result

A total of 16 patients who met the criteria were recruited. The mean age was 46.5years$\pm$(SD16.47), the mean number of fractured ribs was 4.5$\pm$1.37, the mean amount of drained blood was 605.3ml$\pm$(SD244.3) and the mean amount of drained blood per number of the fractured ribs was 134.5ml$\pm$54.29. (Table 1)

Table 1: Shows the age of the patient, the number of fracture ribs, and the amount of blood drained in the pleural space.

S/No	Age(years)	No of # Ribs (Y)	CTTD(ml) /24hrs(X)	CTTD(ml) /No of # Ribs
1	57	3	360	120
2	40	7	750	107
3	24	3	450	150
4	65	3	400	133
5	65	3	300	100
6	74	5	500	100
7	29	6	700	117
8	34	4	500	125
9	45	4	600	150
10	50	7	1000	142
11	29	4	575	144
12	50	6	1200	200
13	65	4	850	213
14	60	4	500	125
15	28	5	600	120
16	29	4	400	100
X(SD)	**46.5±16.47**	**4.5±1.37**	**605.3±244.30**	**134.51±54.29**

#= fractured; CTTD= Amount of blood drained by the chest tube in mls

The correlation between the number of fractured ribs and the amount of blood drained in the pleural space when the chest tube was instituted showed a strong positive correlation between the number of fractured ribs and the amount of haemothorax drained with the chest tube(r=0.8; P-value= 0.001), which implies that an increase in the number of ribs that was fractured leads to an increase in the amount of haemothorax.

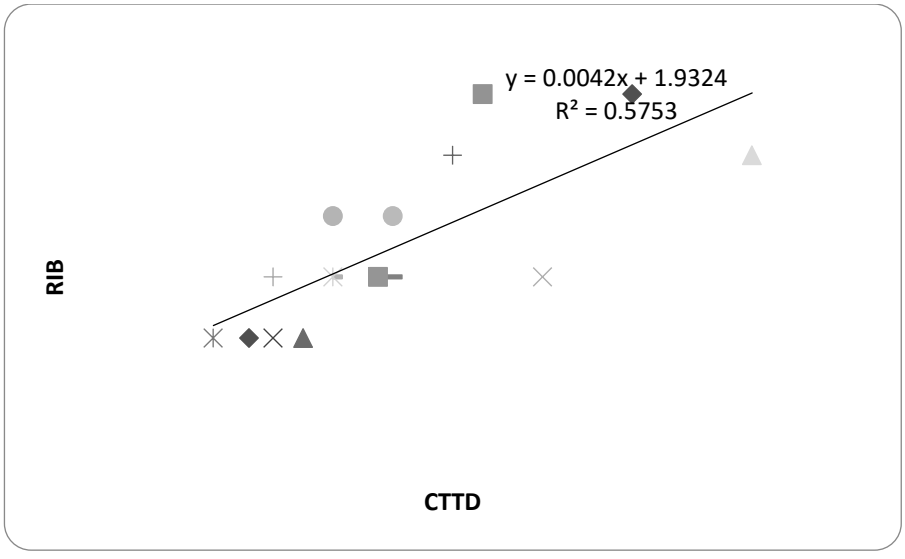

Figure 1. Scatter graph showing the number of fractured ribs (RIB) with the amount of haemothorax in mls(CTTD).

RIB= Number of fractured ribs; CTTD=Amount of haemothorax drained by the chest tube in mls

Discussion

The inferior part of a rib houses the neurovascular bundle which is made of the intercostals nerve and the intercostals vessels. The intercostal arteries are formed from the anterior intercostal arteries that arise from branches of the internal thoracic artery superiorly, and the musculophrenic arteries inferiorly while the posterior intercostal arteries arise directly from the thoracic aorta.[7] Considering the fact that the intercostal arteries emanate from the major artery, the thoracic aorta, bleeding from it when transected can be much even when arterial spasm and clot formation aid to stop the bleeding. Bleeding into the pleural space following chest injury can be from any of the surrounding structures listed above. [8] From anecdotal experience about 100-200mls of blood can be lost from a transected intercostal artery into the pleural space before the body haemastasis can lead to control of bleeding. Again, for this to happen, there should be evidence of the substantial separation of the edges of the fracture.[5] This import of this is that the accompanying intercostal vessels are affected. However, if this happens, one may expect significant bleeding from the vessels to result in haemothorax that should be drained via a chest tube to avoid organized haemothorax that will subsequently become infected and lead to empyema thoracis.

In most of the patients, the chest radiograph did not show significant collection but evidence of fractured ribs. Importantly, the fracture of a rib is expected to lead to the collection of about 80-190mls of blood in the pleural space, and this amount of blood increases with the increasing number of fractured ribs. This haemothorax if not evacuated will lead to retained haemothorax, and retained haemothorax has been shown to be an independent predictor of post-traumatic empyema thoracic.[9] Though a study stated that the source for empyema thoracis may be from inoculation of the pleural space by the injury itself or by tube thoracostomy that was inserted to evacuate the haemothorax following chest injury,[10] this was not our own experience as none of the 16 patients developed empyema thoracic after chest tube was inserted to evacuate the blood.

Conclusion

This study shows that there is a strong positive correlation between the number of fractured ribs as detected by chest radiograph or chest CT scan and the amount of haemothorax drained from the inserted chest tube. Thus, in any patient with a blunt chest injury, and there is a fracture of 3 or more ribs, there may be the need to pass a chest tube irrespective of whether the chest radiograph or chest computerized scan shows evidence of haemothorax.

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