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Original Research Article

Blood gases findings in patients with rib fractures: a retrospective cross-sectional study

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ABSTRACT

Background: Rib fractures are common injuries associated with significant morbidity and mortality. Early diagnosis and management improve outcomes. This study evaluated the role of arterial and venous blood gas parameters in the diagnosis and prognosis of rib fractures.
Methods: A retrospective cross-sectional study included 66 patients with rib fractures who underwent blood gas analysis at King Abdullah Medical Complex Hospital, Jeddah, Saudi Arabia, between 2016 and 2022.
Results: Most patients were male (84.8%), with a mean age of 40.56 years. Older age was associated with a greater number of fractured ribs, higher arterial blood gas (ABG) PCO_2, higher anion gap, and lower venous blood gas (VBG) O_2 saturation. The mean hospital stay was 12.49 days. Higher ABG PO_2 was associated with shorter hospitalization, whereas lateral chest involvement, flail chest, and hemopneumothorax were associated with longer hospital stays. The median number of fractured ribs was 3. A greater number of rib fractures correlated with lower VBG pH, higher PCO_2, and lower HCO_3. Pneumothorax (39.4%) was the most common associated injury, followed by hemothorax (18.2%). Right-sided rib fractures occurred in 62.1% of patients, and 83.3% of hemothorax cases were right-sided. Road traffic accidents accounted for 57.6% of injuries.
Conclusions: ABG and VBG parameters may assist in the diagnosis and prognosis of rib fractures. Pneumothorax was the most common associated injury, followed by hemothorax, while road traffic accidents were the leading mechanism of injury. The mean hospital stay was 12.49 days.

Keywords: Arterial blood gases, Blood gases, Rib fracture, Thoracic trauma, Venous blood gases

INTRODUCTION

After cancer and vascular disease, trauma is the third most prevalent cause of mortality in the world, accounting for 9-10% of deaths.[1,2] It is also the primary reason for emergency admission and the source of almost 16% of all medical costs worldwide.[1] With an incidence of 45-65%, chest trauma is one of the most frequent injuries suffered by poly-trauma patients. Mortality rates for this kind of trauma, which is typically brought on by a high-energy blunt force, can reach 60%, which make it one of the leading causes of death in all age groups. 15% of all trauma admissions is related to chest trauma.[3-5] Rib fracture is the most common injury associated with chest trauma with overall mortality rate about 10%.[6,7]

For critically ill patients, an arterial blood gas (ABG) gives crucial information. In general, the base excess (BE) is a useful indicator of substantial injuries in trauma patients (BE less than −4).[8] In trauma patients suspected of being at risk for significant injury based on initial history and physical examination, there is evidence to support routine blood gas investigation for base deficit and metabolic acidosis evaluation. However, the best way to decide whether to have an arterial or venous blood gas is to evaluate the patient's while taking arterial oxygen saturation and tissue perfusion status into account.[9] Although carbon dioxide elimination may be almost unaffected, a crushed chest injury implies significant violence to the thorax, which mostly cause lung damage. This results in a decrease in the amount of oxygen in the arterial blood. The arterial blood's oxygen content will continue to decrease due to ongoing hemorrhage, lobular atelectasis brought on by secretions, hemothorax and/or pneumothorax, discomfort, and central respiratory depression brought on by an injury or analgesic medication. Finally, when lung failure approaches, acidosis will develop and the arterial blood's carbon dioxide concentration will increase.[10,11]

Numerous studies have demonstrated that having more fractured ribs and their locations are risk factors for respiratory failure and death.[12] In a study, in deciding which patients were admitted to the ward and which were admitted to the intensive care unit, ABG values and combined ABG values were statistically significant. Patients admitted to the ICU had respiratory acidosis, hypercarbia, and hypoxia.[6]

Since rib fracture is the most common injury associated with chest trauma, our study aimed to find the factors of rib fracture that is associated with significant abnormalities in ABG and VBG, which are found in studies more predictive for ICU admissions.

Objective

To determine the relationship between arterial and venous blood gas abnormalities and the severity and characteristics of rib fractures, assessing their value in the diagnosis and prognosis of rib fracture patients.

METHODS

Study design

This was a cross-sectional study that aimed to measure the ABG and VBG values in patients that are presented with any kind of rib fractures, and provides supportive study that helps in the laboratory diagnosis and prognosis of rib fracture. We used observation records using a checklist that was tested and validated by a team of experts.

Study area

The study was conducted in the Institute of King Abdullah medical complex, Jeddah, Saudi Arabia carried out from December 2016 to January 2022.

Study population

From December 2016 through January 2022, we examined 120 electronic records of patients with x-ray confirmed rib fractures at King Abdullah Medical Complex Hospital. We excluded 54 records, either due to concurrent pulmonary diseases or missing ABG/VBG data, leaving 66 patients eligible for our final analysis.

The sample size of 66 corresponds to the total number of eligible patients with documented ABG or VBG during the study period. A randomized sample of these adult patients (≥18 years) with x-ray-confirmed rib fractures and documented ABG or VBG was selected from the electronic records of King Abdullah Medical Complex. We conducted simple random sampling from the hospital's electronic records to reduce selection bias and ensure representation of all eligible patients during the study period. Patients with other pulmonary injury and diseases were excluded.

Data collection

A validated data collection sheet designed using Excel used to assess the correlation between different blood gasses and ribs fractures. The sheet consists of 4 sections: 1st section: demographic data included age and sex, hospital stay and date of admission. 2nd section: ribs and lung assessment: number of broken ribs, affected side (right or left), the exact location (anterior, posterior, lateral, antro-lateral, postero-lateral) the type of fracture (displaced or non-displaced), flail chest, lung contusions, other injuries, mechanism of injury.

3rd section: ABG findings (PH, PO_2, PCO_2, HCO_3, O_2 saturation, base excess and deficit, anion gap with and without potassium (K), ABG interval): each was taken at admission and post admission with specifying the duration between them.

4th section: VBG findings: (PH, PO_2, PCO_2, HCO_3, O_2 saturation, base excess and deficit, anion gap with and without potassium (K), VBG interval): each was taken at admission and post admission with specifying the duration between them.

The readings were taken twice if available, once at admission and the second was 24 hours post admission.

Statistical analysis

In the present study, statistical analysis using "IBM SPSS statistics version 23.0" test the objectives was applied to evaluate and Shapiro-Wilk test was used to test the normality of the study samples. Shapiro-Wilk test was used to test the normality of the study samples. Descriptive statistics to calculate median and quartiles. Descriptive statistics to calculate median and quartiles. Mann-Whitney test was applied to test the significant difference between two groups. Kruskal-Wallis test was applied to test the significant difference between three or more groups. Wilcoxon test was applied to test the significant difference between two related groups. Pearson's correlation was used to measure the strength and direction of association between two variables.

Pearson's correlation test was used to explore the relationships between age, number of fractured ribs, and both arterial and venous blood gas parameters, recognizing that no multivariable adjustment was performed in this retrospective design. Missing data were minimal (<5% for any variable) and were addressed through complete-case analysis by excluding records with missing values. Since our study included all eligible patient records during the study period (census sampling), no sampling weights or stratification were applied. Finally, no subgroup or sensitivity analyses were conducted.

Ethical considerations

The current study was approved by the research ethics committee of King Abdullah medical complex hospital at Jeddah, approval number H-02-J-002. In our study we didn't collects any participants personal identifiers to protect their confidentiality. Furthermore, the collected data was used for research purposes only.

RESULTS

There were total 66 patients included in our study with mean age of the study sample of 40.5±18.8. 56 (84.8%) of them were males while the rest 10 (15.2%) were females. Missing data were minimal (<5% for all variables) and were handled via complete-case analysis. Baseline characteristics are summarized in (Table 1).

Blood gases

Arterial blood gasses

A total of 21 (31.81%) patients had an ABG at admission, compared to only 10 (15.15%) that had an ABG post admission and 7 (10.60%) had both reading at and post admission, their median for at admission versus post admission is as follows: PH were (7.301±0.09 versus 7.276±0.196; p value 0.612), PO_2 (110±143.425 versus 111±158.919; p value 0.499), PCO_2 (45.1±11.807 versus 44.6±14.761; p value 0.31), HCO_3 (21.05±4.803 versus 19.9±6.355), O_2 saturation (97.6±22.436 versus 97.15±19.054; p value 0.499), Base excess and deficit (-4.7±4.742 versus -5.15±8.211; p value 0.499) and anion gap (17.15±7.854 versus 10.4±9.819; p value 0.248) (Table 2). The correlation between ABG findings at admission and patient's demographic data showed that older patients had a higher PCO_2 (r=0.474; p value 0.035) and anion gap (p value 0.036). Sex differences showed no relevant correlation.

Venous blood gasses

From the total of 42 (63.63%) patients had an VBG at admission, only 13 (19.69%) had an VBG post admission, while 11 (16.67%) of them had both reading at and post admission, their median for at admission versus post admission were as follows: PH (7.354±0.077 versus 7.315±0.276; p value 0.093), PO_2 (33.3±13.118 versus 40.5±22.673; p value 0.333), PCO_2 (43.05±7.237 versus 44.7±11.886; p value 0.286), HCO_3 (22.55±2.825 versus 19.9±5.51), O_2 saturation (59.4±21.989 versus 60.4±18.785; p value 0.79), base excess and deficit (-1.4±3.628 versus -4.3±7.167; p value 0.041) and anion gap (15.585±4.05 versus 15.45±8.205; p value 0.625) (Table 2). The correlation between VBG findings at admission and patient's demographic data found that there was a significant decrease of O_2 saturation (r=-0.422; p value 0.007) found in older age patients, while there wasn't significant correlation with longer sex differences.

Rib fracture

Affected side

There were 25 (37.88%) of patients with left side involvement while right rib fractures accounts for 31 (46.97%), the bilateral rib fractures were found in 10 (15,15%) (Table 3). There was significant relation with VBG changes at admission with PH for left, right and both sides as follows: (7.383 versus 7.318 versus 7.350; p value =0.008), respectively, and the PCO_2 (40.550 versus 45.200 versus 42.150; p value =0.027), respectively. There was no significant association between the affected side with gender or age.

Table 1: Baseline demographic and clinical characteristics of patients with rib fractures (n=66).

Sex					
		Frequency	Percent	Valid percent	Cumulative percent
Valid	Male	56	84.8	84.8	84.8
	Female	10	15.2	15.2	100.0
	Total	66	100.0	100.0	

Table 2: Comparison of arterial and venous blood gas parameters at admission and post-admission.

	Numbers of tested patients	Percentiles				Numbers of tested patients	Percentiles			P value of changes in values at admission versus post admission
		25th	50th (Median)	75th			25th	50th (Median)	75th	
ABG PH at admission	21	7.249	7.301	7.384	ABG PH post admission	10	7.068	7.276	7.375	0.612
VBG PH at admission	42	7.283	7.354	7.381	VBG PH post admission	13	7.151	7.315	7.361	0.093
ABG PO_2 at admission "mmHg"	19	57.200	110.000	266.000	ABG PO_2 post admission "mmHg"	10	65.675	111.000	376.250	0.499
VBG PO_2 at admission "mmHg"	39	25.600	33.300	47.000	VBG PO_2 post admission "mmHg"	12	33.175	40.500	51.450	0.333
ABG PCO_2 at admission "mmHg"	20	38.525	45.100	55.650	ABG PCO_2 post admission "mmHg"	10	38.575	44.600	50.100	0.310
VBG PCO_2 at admission "mmHg"	42	40.350	43.050	50.175	VBG PCO_2 post admission "mmHg"	13	41.500	44.700	59.450	0.286
ABG HCO_3 at admission "mmol/l"	20	18.000	21.050	24.500	VBG HCO_3 post admission "mmol/l"	13	16.950	19.900	22.150	0.753
VBG HCO_3 at admission "mmol/l"	42	20.325	22.550	23.625	ABG HCO_3 post admission "mmol/l"	10	11.125	19.900	25.725	0.500
ABG O_2 saturation at admission "%"	19	86.400	97.600	99.000	ABG O_2 saturation post admission "%"	10	82.425	97.150	99.225	0.499
VBG O_2 saturation at admission "%"	40	43.775	59.400	81.250	VBG O_2 saturation post admission "%"	13	53.700	60.400	82.800	0.790
ABG base excess and deficit at admission "mmol/l"	19	-7.600	-4.700	-3.800	ABG Base excess and deficit post admission "mmol/l"	10	-16.925	-5.150	1.050	0.499
VBG Base excess and deficit at admission "mmol/l"	41	-3.600	-1.400	0.300	VBG Base excess and deficit post admission "mmol/l"	13	-7.800	-4.300	-1.800	0.041
ABG anion gap at admission "mmol/l"	14	9.600	14.200	17.075	ABG anion gap post admission "mmol/l"	9	0.550	6.900	11.700	0.249
ABG anion gap at admission with K "mmol/l"	14	13.275	17.150	21.050	ABG anion gap post admission with K "mmol/l"	9	4.550	10.400	16.150	0.248
VBG anion gap at admission "mmol/l"	40	8.150	12.200	14.350	VBG anion gap post admission "mmol/l"	12	9.500	11.750	16.150	0.790
VBG anion gap at admission with K "mmol/l"	40	11.900	15.585	18.675	VBG anion gap post admission with K "mmol/l"	12	13.900	15.450	20.435	0.625

Table 3: Distribution of rib fractures by affected side and associated blood gas findings.

Affected side					
		Frequency	Percent	Valid percent	Cumulative percent
Valid	Left	25	37.9	37.9	37.9
	Right	31	47.0	47.0	84.8
	Both	10	15.2	15.2	100.0
	Total	66	100.0	100.0	

Table 4: Characteristics and blood gas associations of right-sided rib fractures.

	No		Yes	
	Count	%	Count	%
Ribs fractured (right) 1st	55	83.3	11	16.7
Ribs fractured (right) 2nd	48	72.7	18	27.3
Ribs fractured (right) 3rd	50	75.8	16	24.2
Ribs fractured (right) 4th	52	78.8	14	21.2
Ribs fractured (right) 5th	54	81.8	12	18.2
Ribs fractured (right) 6th	51	77.3	15	22.7
Ribs fractured (right) 7th	54	81.8	12	18.2
Ribs fractured (right) 8th	56	84.8	10	15.2
Ribs fractured (right) 9th	57	86.4	9	13.6
Ribs fractured (right) 10th	58	87.9	8	12.1
Ribs fractured (right) 11th	63	95.5	3	4.5
Ribs fractured (right) 12th	64	97.0	2	3.0

Table 5: Characteristics and blood gas associations of left-sided rib fractures.

	No		Yes	
	Count	%	Count	%
Ribs fractured (left) 1st	57	86.4	9	13.6
Ribs fractured (left) 2nd	58	87.9	8	12.1
Ribs fractured (left) 3rd	59	89.4	7	10.6
Ribs fractured (left) 4th	58	87.9	8	12.1
Ribs fractured (left) 5th	58	87.9	8	12.1
Ribs fractured (left) 6th	53	80.3	13	19.7
Ribs fractured (left) 7th	56	84.8	10	15.2
Ribs fractured (left) 8th	56	84.8	10	15.2
Ribs fractured (left) 9th	57	86.4	9	13.6
Ribs fractured (left) 10th	60	90.9	6	9.1
Ribs fractured (left) 11th	60	90.9	6	9.1
Ribs fractured (left) 12th	63	95.5	3	4.5

Table 6: Mechanisms of injury among patients with rib fractures.

Mechanism of injury					
		Frequency	Percent	Valid percent	Cumulative percent
Valid	Assault by bodily force	1	1.5	1.5	1.5
	Fall to another level	7	10.6	10.6	12.1
	Falling	11	16.7	16.7	28.8
	Jet ski accident	3	4.5	4.5	33.3
	Pedestrian accident	2	3.0	3.0	36.4
	Pedestrian trauma	1	1.5	1.5	37.9
	RTA	38	57.6	57.6	95.5
	Struck by horse	1	1.5	1.5	97.0
	Thrown by horse	1	1.5	1.5	98.5
	Unknown	1	1.5	1.5	100.0
	Total	66	100.0	100.0	

Number of broken ribs

All the 66 patients had a broken rib with (Median 3±2.366). Increased number of broken ribs were significantly related to different VBG changes at admission, such as Ph (r: -0.448, p value: 0.003), PCO_2 (r: 0.376, p value: 0.014) and HCO_3 (r: -0.321, p value: 0.038). Also ABG PO_2 at admission is significantly increased with the number of broken ribs (p value: 0.043).

Right rib fracture

There were a total of 41 patients with involvement of the right ribs, 31 (75.6%) of them had isolated right ribs fractures, while 10 (24.4%) had bilateral involvement of ribs fractures. The 2nd, 3rd, and the 6th ribs were most commonly fractured in the right side with 18 (27.3%), 16 (24.2%), and 15 (22.7%), respectively (Table 4). Nondisplaced fracture showed a slight tendency over displaced with 25 (37.9%) versus 19 (28.8%) while 3 (4.5) samples were committed. Posterior involvement of the right ribs were the most common involvement followed by anterior involvement with 21 (31.8%) and 16 (24.2%), respectively. In the VBG values at admission, when 3rd, 4th and 6th ribs were involved, it predicts lower O_2 saturation (median 64 versus 39; p value =0.025), (Median 64 versus 39; p value =0.013), and (median 66 versus 45; p value =0.032), respectively. Usually, 6th and 7th ribs were associated with more abnormal VBG values at admission; beside lower O_2 saturation, 6th right rib was also associated with lower PH, higher CO_2 and higher anion gap (medians; 7.366 versus 7.255; p value: 0.001, 46 versus 51; p value: 0.022, 17.2 versus 18.55; p value: 0.008, respectively), while the 7th right rib fracture mostly predict lower PH, lower HCO_2 and higher anion gap (medians; 7.361 versus 7.25; p value: 0.009, 22.75 versus 19.85; p value: 0.04, 15.2 versus 18.8; p value: 0.039). The 12th right rib also predicts higher anion gap (median: 15.3 versus 20.2; p value: 0.044). While in ABG 10th right rib fracture involvement was associated with benign finding in comparison when it was not fractured (median; 7.237 versus 7.357; p value: 0.044).

Left rib fracture

There were a total of 35 patients with involvement of the left ribs, 25 (71.43%) of them had isolated left ribs fractures, while 10 (28.57%) had bilateral involvement of ribs fractures. The 6th, 7th, and 8th were the most commonly involved in the left side with 13 (19.7%), 10 (15.2%), 10 (15.2%), respectively (Table 5). With 21 (31.8%) versus 18 (27.3%) for displaced versus nondisplaced in contrast to the right side. But the results regarding the exact location upon the rib were consistent with the right with 21 (31.8%), and 9 (13.6%) for posterior followed by anterior involvement. The relation to blood gasses at admission, the 6th rib fractured predicted a higher VBG- HCO_3 (median 21.500 versus 23.600; p value =0.031), while the 7th rib fractured had a lower ABG anion gap (medians; 18.850 versus 7.850; p value =0.028). There was a tendency for the left 7th, 8th,10th ribs to be associated with lung contusion (2.9% versus 29%; p value =0.004), (2.9% versus 29%; p value =0.004), (22.9% versus 58.1%; p value =0.005) respectively.

Mechanism of injury

Regarding the mechanism of injury it shows variation but the major one which accounts for 57.6% was RTA, the next was fall with a total of 27.3 divided into 16.7% simple falling, while falling to another level was 10.6%. There was no association between the mechanism of injury and side affected (Table 6).

Other injuries

Regarding injury associated with the rib fractures; pneumothorax followed by hemothorax were the commonest injuries with incidence of 39.4% and 18.2%, respectively. The incidence of clavicular fracture, pleural effusion, scapular fracture, sternal fracture, and atelectasis were 12.1%, 12.1%, 10.6%, 9.1%, and 7.6%, respectively. Hemothorax and surgical emphysema were more likely to happen in older ages (median ages for their presence versus absence: 56 versus 31; p value: 0.008, and 71 versus 35; p value: 0.048).

Hospital stay

The mean of hospital stay was mean =12.485±20.941. There was no significant difference between males or females in terms of hospital stay, with a median of 6 versus 4, respectively; p value =0.184. There was a significant increase of hospital stay with ABG PO_2 values at admission; R=0.637, p value =0.00.

DISCUSSION

In this retrospective cross-sectional study, we demonstrated that increasing age and number of rib fractures were significantly associated with elevated $PaCO_2$ and anion gap in arterial blood gases (ABG) as well as decreased O_2 saturation in venous blood gases (VBG). These findings highlight the need for early respiratory monitoring in older patients and those with multiple rib fractures.

Blood gases

Rotab et al study showed that patients with chest trauma exhibit initial low arterial pH when they don't have lung injuries compared to chest trauma patients with lung injury and when hospital stay was 4 days or more compared to less than 4 days (7.33±0.04 versus 7.35±0.09, and 7.32±0.13 versus 7.37±0.045, respectively), the study also showed that chest trauma patients with lung injuries show more increased arterial PCO_2 level compared to chest trauma patients with lung injury (43.23±9.43 versus 42.85±1.26), and decreased level of arterial PO_2, HCO_3, and SaO_2 (56.85±4.91 versus 62.84±2.50, 20.43±2.41 versus 23.37±2.32, and 81.75±17.38 versus 86.41±12.62, respectively).[6] When the hospital stay was 4 days or more the study showed high arterial PCO_2 and HCO_2 (47.69±6.33 versus 40.27±5.59 and 23.77±2.72 versus 22.97±2.15, respectively) and low arterial PO_2 and SaO_2 (51.09±9.53 versus 68.79±8.47 and 77.27±13.48 versus 91.04±9.38). These findings are consistent with our finding regarding the low pH and high PCO_2, while our study contradicts it

that HCO_3, and O_2 saturation were normal initially, knowing that HCO_3 did decrease after 24 hours, and high PO_2. While the result of Carlino et al showed similar results regarding non lung injury versus lung injury patients in arterial PaO_2 and SaO_2 (78.78±8.01 versus 64.45±11.46 and 98.11±0.78 versus 94.62±4.18, respectively) there was contradiction with the results of initial pH value for non lung injury versus lung injury which exhibit that pH in non lung injury was higher compared to lung injury group (7.44±0.03 versus 7.43±0.04).[13] Tsai et al study calculated the following arterial results of PH, PaO_2, $PaCO_2$, HCO_3, and SaO_2 for survivors with the following results (7.33±0.06, 129.09±58.76, 40.89±8.10, 21.29±4.58, and 95.48±8.29, respectively) and for non-survivors the results were (7.28±0.133, 125.60±130.81, 45.01±10.99, 20.43±3.35, and 81.41±28.30, respectively), results which show increased levels of PaO_2 in contrast to Rotab et al and Carlino et al and consistent with our research results.[6,13,14] Bellone et al study only measured arterial SaO_2 parameter and calculated the mean with 96% (94-98%) in patients with blunt chest trauma.[15] Measuring the difference in at admission ABG compared to 6 hours post admission Mohsenian et al found that PH, SaO_2, PCO_2, HCO_3, base excess at admission and 6 hours after admission in traumatic injuries with femur and pelvis fractured were 7.34±0.088 versus 7.32±0.086, 92.1±6.68 versus 95.98±2.47, 40.69±11.02 versus 37.99±10.44, 22.12±4.18 versus 20.40±4.05, and -3.251±4.117 versus -4.531±5.748, respectively.[16] Our did show decreased pH arterial value 24 hours later, with both value below normal range, our study showed an increased O_2 saturation and further increasing 24 hours later, PCO_2 in our study were both in normal ranges with decreasing in the PCO_2 value 24 hours later, the HCO_3 values did consistent with our findings except that we found an abnormal decreasing in the value 24 hours later, and regarding base deficit the finding were compatible.

Rib fracture

In Carlino et al study the number of broken ribs with a blunt chest detected by CT was higher in patients with lung injury in comparison to patients without lung injury (3.67±1.87 versus 1.33±1.23).[13] Schmoekel et al study ribs fractures in patients aged 55 or older and found that patients having more than >6 ribs fractured were 18.3%, 13.4% having bilateral ribs involvement, and 7.6% having the first rib fractured.[17] The number of fractured ribs in chest blunt trauma patients admitted to ICU in Bellone et al study were 3 ribs or more in 70% of cases and 30% were having less than 3 ribs involved with 4 ribs as a median for number of fractured ribs.[15] In Shulzhenko et al the percentages for 1 fracture, 2 fractures, 3 fractures, 4 fractures, 5 fractures, 6 fractures, 7 fractures, and 8 fractures of the ribs were 23.1%, 18.3%, 15.7%, 15.4%, 8.6%, 6.0, 4.2%, and 8.8%, respectively.[15] While in our study, the second rib was most commonly involved in the right chest while the sixth rib was the most commonly involved in the left side. Finally, 21% of patients with blunt trauma had rib fractures in Cameron et al study.[18]

Mechanism of injury

Carlino et al mentioned fall-related injury as the most common cause of chest trauma 64.7%, followed by motor vehicle crash 27.5%, findings which correlate with Shulzhenko et al study for the falls being the commonest mechanism of injury (43.2%) followed by motor vehicle collision (30.4%).[12,13] Tsai et al mentioned different findings with road accidents being the most common cause of chest injury followed by falling injury 66.67% versus 20%.[14] Cameron et al agreed with the latter findings with the commonest cause for injury with 48.05% of ribs being fractured by motor vehicle collision.[18] In our study motor vehicle collision was also the most common, followed by falling.

Other injuries

Hemothorax and pneumothorax were common to be reported as the common associated injury in chest trauma, Rotab et al and Tsai et al found hemothorax as the most common (60% in Tsai et al after rib fracture) while Carlino et al found the opposite, so was our findings.[13,14,16] The results of Carlino et al and our results were similar to schmoekel et al with pneumothorax being the commonest associated injury in elderly (23.6%) followed by hemothorax (10.6%).[13,17]

Hospital stay

The length of hospital stay in Rotab et al study was 5.03±3.56 with a median of 4 days of hospital stay.[6] Shulzhenko et al and Bellone et al found relatively longer mean of 7.9 and 6.4 days, respectively, while Cameron et al trial showed a longer duration in comparison with average length of hospital stay for rib fractures 16.16±24.3 days.[12,15,18] Tsai et al study found even a longer mean of hospital stay with 50.8 days.[14] Our study found that the mean of hospital stay was 12.4 days.

We faced different limitations in our study, first is that this is a retrospective study, so it all depends on the registered data. Most of the patients who have had an ABG or VBG at admission don't have post admission testing. Second is that the sample size is limited because of that not all the patients with blunt chest trauma and rib fracture received an ABG or VBG test. Third is that this study was done only in one center.

CONCLUSION

In our retrospective cross-sectional study, we observed that older patients and those with multiple rib fractures tended to have more pronounced abnormalities in both arterial and venous blood gas values. We believe this underscores the importance of closer respiratory monitoring in these high-risk patients. Although our

single-center, retrospective design may limit generalizability, we nevertheless feel these findings are applicable to similar tertiary-care hospitals treating rib trauma and hope they will inspire larger prospective, multicenter studies to confirm and build upon our work. Our findings indicate that ABG and VBG values can be helpful in the management of rib fractures. Generally, patients exhibited low arterial and venous pH, which further decrease 24 hours later, normal PCO_2 values for arterial and venous samples at and post admission, except for slight elevation in arterial PCO_2 at admission, normal at admission arterial and venous HCO_3, which got into a slight abnormal decreasing in post admission values, decreased base excess which also had a further decreasing in post admission values. Median of 3 ribs fractured for a patient, with pneumothorax being the most common associated injury followed by hemothorax. Motor vehicle collision is the most common mechanism of injury followed by falling, mean hospital stay was 12.485 for a patient.

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