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Comparison between intubation and noninvasive ventilation in management of ICU chest trauma patients

Gaser Ali, Ehab Sobhy

Department of cardio-thoracic surgery, Zagazig University Hospital, Zagazig, Egypt

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ABSTRACT

This study aims to compare the effectiveness of endotracheal intubation with mechanical ventilation and noninvasive ventilation as the most in common methods used in management of ICU chest trauma patients. Sixty-eight patients with chest trauma aged 20–70 years were participated in this study for 2 years. The patients attended to cardiothoracic surgery department, Zagazig University Hospital. The Patients enrolled in this study were divided into 2 groups: the first one received endotracheal intubation with mechanical ventilation (MV group) (Group 1, n = 34) and the other received noninvasive ventilation (NV group) (Group 2, n = 34). All enrolled patients were monitored with clinical criteria including RR, HR, MAP and SpO2. The software SPSS was used for the statistical analysis. P value < 0.05 was considered as statistically significant. The present study resulted that the mean HH, HR, pO2, pCO2 and P/F ratio were improved in the MV group as well as in the NV group but this improvement was not significant. The use of noninvasive ventilation reduces mortality, damages, and complications as well as the length of stay in intensive care (ICU), which leads to low cost.

Keywords: Noninvasive ventilation, chest trauma, intubation

1. INTRODUCTION

Chest trauma considers a common cause of morbidity and mortality, particularly in the young patients (Mirka et al., 2012). In trauma patients, the thoracic injuries represent third injuries; it comes after head and extremities injuries. Elbaih et al. (2016) reported that the mortality rate of thoracic trauma ranges from 15–25%, which considers the highest with tracheobronchial-esophageal and cardiac injuries. Chest trauma is the most common cause of death in approximately 25% of multiple system trauma patients. Particularly, pulmonary contusion is common in about 17% of multiple traumas patients (Szucs-Farkas et al., 2010). It has been recorded that post-traumatic respiratory failure is due to the increased amount of intra-alveolar and interstitial fluids, which describes the concept of traumatic wet lung. It is recommended allowing positive airway pressure through mask for ensuring proper ventilation (Chiumello et al., 2013).

Trauma patients are a group of heterogeneous patients with diverse respiratory requirements. The method and severity of respiratory support and ventilation depend on the degree of respiratory dysfunction, severity of gas exchange weakness, associated injuries, and the usefulness of non-invasive ventilation (NIV) as a primary means of dealing with the condition (Karcz & Papadakos, 2015). To date, the usefulness of NIV in dealing with respiratory problems of trauma patients has not been adequately and widely investigated. Over the past 20 years, several studies and reports have shown that NIV can be effective in trauma patients as a means of preventing or treating respiratory failure. Therefore, NIV has expanded around the world (Schreiber et al., 2018). Non-invasive ventilation allows for greater flexibility in applying ventilator assistance and maintaining airway defense mechanisms. The application of non- invasive ventilation may reduce the duration of ICU stay of traumatized hypoxic patients and preventing respiratory complications (Keenan et al., 2011). Hence, this study aims to compare the effectiveness of endotracheal intubation with mechanical ventilation and noninvasive ventilation as the most in common methods used in management of ICU chest trauma patients.

2. PATIENTS AND METHODS

Sixty-eight patients with chest trauma aged 20–70 years were participated in this study for 2 years. The patients attended to cardiothoracic surgery department, Zagazig University Hospital. The study was conducted during January 2018- February 2020.

Table 1 The criteria of the patients enrolled in this study

Criteria	Score
Glasgow coma scale (GCS) score	>12
Respiration rate	>35/min
PO2	<80%
SpO2	<90% with FiO_2 0.5%

Exclusion criteria

Patients with traumatic brain injury
Patients with severe hemodynamic instability
Patients who subjected to emergency gastrointestinal surgery
Patients who had inability for the protection of the airway
Patients with facial trauma
Patients who showed no cooperation to use the facemask

Thoracic Trauma Severity Score (TTSS) has been used to assess the severity of chest injury. A standardized scoring system was used for evaluation of blunt chest trauma according to Pape et al. (2000), 25-point score with five parameters were used (Table 2).

The Patients in this study were divided into 2 groups: the first one received endotracheal intubation with mechanical ventilation (MV group, n = 34) and the other received noninvasive ventilation (NV group, n = 34). Table 3 illustrates the treatments received by each group.

Table 2 TTSS to assess the chest injury severity

Degree	Age	PaO_2/FiO_2	Pleural effusion	Contusion	Rib fracture	Point
0	<30	>400	None	None	0	0
I	30-40	300-400	PT	Unilobar unilateral	1-3	1
II	41-55	200-300	HT/HPT (U/L)	Unilobar bilateral or bilobar unilateral	3-6	2
III	56-70	150-200	HT/HPT (B/L)	bilateral < 2 lobes	< 3 bilateral	3
IV	>70	<150	HPT	Bilateral ≥ 2 lobes	Flail chest	4

Where: PT= pneumothorax; HPT= Hemopneumothorax; HT= Hemothorax.

Table 3 The protocol for the two studied groups

MV group, *n* = 34	**NV group, *n* = 34**
Intubated with 7–8 mm endotracheal tube was done, ventilator settings with assist-control for generation of tidal volume ranges from 6–8 mL/kg	Biphasic positive airway pressure was maintained
RR < 25%, plateau pressure below 30 cm H_2O	Inspiratory positive airway pressure was maintained at 8 cm H_2O , EPAP at 4 cm H_2O
Positive end expiratory pressure was increased gradually for maintaining of SpO2 more than 90% with Fi = 0.6	IPAP titrated for achieving tidal volume = 6 mL/kg and the respiration rate less than 25/min
Midazolam infusion was used for sedation	Expiratory positive airway pressure was maintained for SpO2 greater than 90% (Fi of 0.6) and minimize the patient intolerant leak
Extubation was done if Patients maintain RR less than 25, SpO2 greater than 95%, and pO2 greater than 80 (Fi of 0.4).	

All enrolled patients were monitored with clinical criteria including RR, HR, MAP and SpO2. The blood gas analysis was done before intubation or NIV and one hour after application then followed up daily or according to the need. Serial chest X-rays were done to assess the radiological betterment. All enrolled patients were subjected to pain control protocol using intravenous paracetamol injection and fentanyl patch (50 mcg/hr) was used. All enrolled patients were observed for complications and mortality. The software SPSS was used for the statistical analysis. *P* value < 0.05 was considered as statistically significant.

3. RESULTS

Sixty-eight patients with chest trauma aged 20–70 years were participated in this study for 2 years. The patients attended to cardiothoracic surgery department, Zagazig University Hospital. The Patients in this study were randomly divided into two groups: the first one received endotracheal intubation with mechanical ventilation (MV group, *n* = 34) and the other received noninvasive ventilation (NV group, *n* = 34). Because of the worsening of respiratory parameters, one patient needed emergency intubation in the NV group. It was not excluded any of the patients from the study. Table 4 shows the Comparison of both the MV group, *n* =34) and the NV group, *n* =34) in terms of physiological parameters and clinical baseline. The table 4 shows that there is no statically significant differences in age of the patients between the MV group, *n* =34) and the NV group, *n* =34) similarly in both weight and sex.

The table 5 presents that the primary outcome between the MV group and the NV group. In both groups, we considered the duration of ICU survival, mortality as well as complications as a primary outcome. It was observed that in the NV group the average duration of intensive care was lower, although the differences were not significant between them and the MV group. The following table shows that the rate of complications including hospital infection and ARDS was significantly higher (P = 0.010) in the MV group of the NV group, which included ten hospital infection patients and one symptomatic patient, while only one patients had hospital infection in the NIV group.

Table 4 Comparison of both MV group, *n* =34 and the NV group, *n* =34 in terms of physiological parameters and clinical baseline.

Variable	Sex (male/ female)	Age (year)	Weight (kg)	RR	HR	pO2	pH	pCO2	TTSS at admission	P/F ratio
MV group , n = 34	32/2	39.35 ±8.24	54.88±6.00	41.39±6.45	122.21±7.89	53.22±6.05	7.36±0.047	50.12±4.42	11.91±2.23	235.16±18.31
NV group , n = 34	32/2	37.89 ±7.65	56.58±5.77	40.78±5,19	126.74±11.02	56.32±9.01	7.35±0.039	52.44±6.79	11.31±2.40	230.68±23.43

Table 5 The primary outcome between MV group and NV group

Variable	ICU stay	Complication	Mortality
MV group (*n* = 34)	13.98±4.67	22 (64.7%)	12(35.30%)
NV group (*n* = 34)	11.09±2.72	2 (5.88%)	2(5.88%)
p	0.130	0.010	0.070

The Figure 1 illustrates the Comparison between MV group and NV group to compare mean heart rate at different time intervals per minute. The graph shows that there was a very significant decrease (P <0.001) in the HR average of the MV group after one hour of the start of mechanical ventilation compared to the NV group.

Figure 1 Comparison between MV group and NV group to compare mean heart rate at different time intervals per minute.

The Figure 2 describes a comparison between both the MV group and the NV group in terms of average respiratory rate through different time periods per minute. It is apparent from the chart that, the respiratory rate was improved in MV group as well as in NV group but this improvement was not significant.

Figure 3 and 4 shows a comparison between both the MV group and the NV group in terms of mean pO2 and mean pCO2 through different time periods per mmHg. It can be seen from the figure 3 and 4 that, the mean pO2 and mean pCO2 were improved in MV group as well as in NV group but this improvement was not significant.

Figure 5 shows a comparison between both the MV group and the NV group in terms of mean P/F ratio at different time intervals. It is apparent from the chart that, the mean P/F ratio was improved in MV group as well as in NV group but this improvement was not significant. In the NV group, it was observed within 24 hours that oxygen was significantly improved; thereafter it was equal to the MV group and in the NV group, it was observed that the MV group was significantly lower than the

comparative NV group. To maintain optical analog scale (VAS) analgesia is maintained in both groups I find a score below 2 so as to compare them.

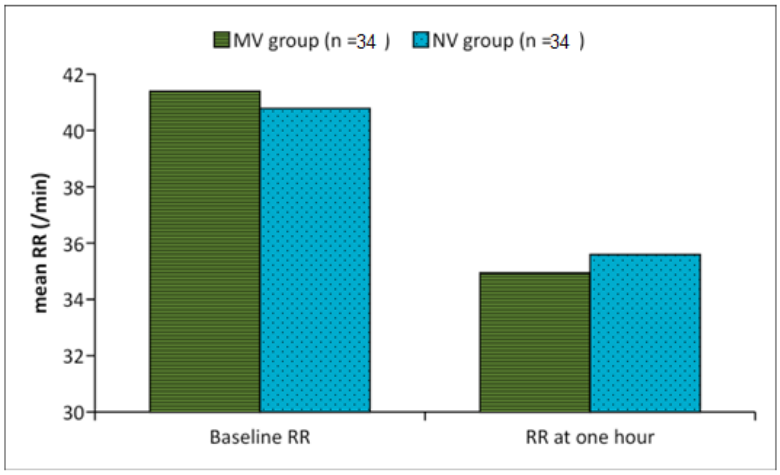

Figure 2 A comparison between both the MV group and the NV group in terms of average respiratory rate through different time periods per minute.

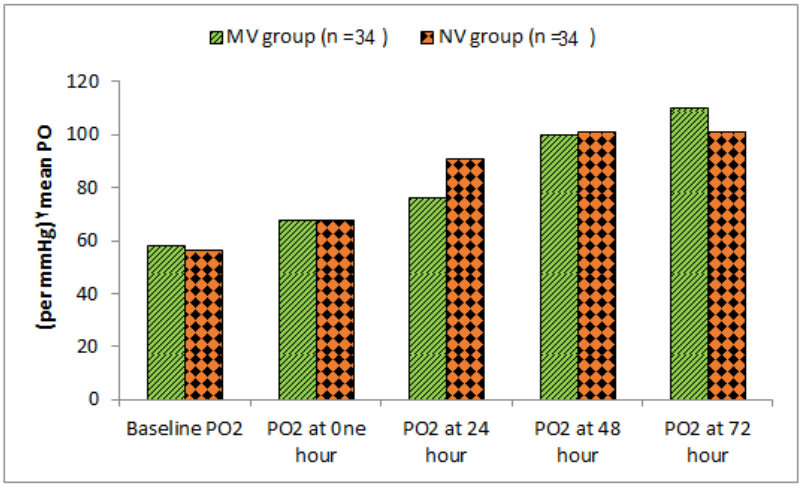

Figure 3 A comparison between both the MV group and the NV group in terms of mean pO2 through different time periods per mmHg.

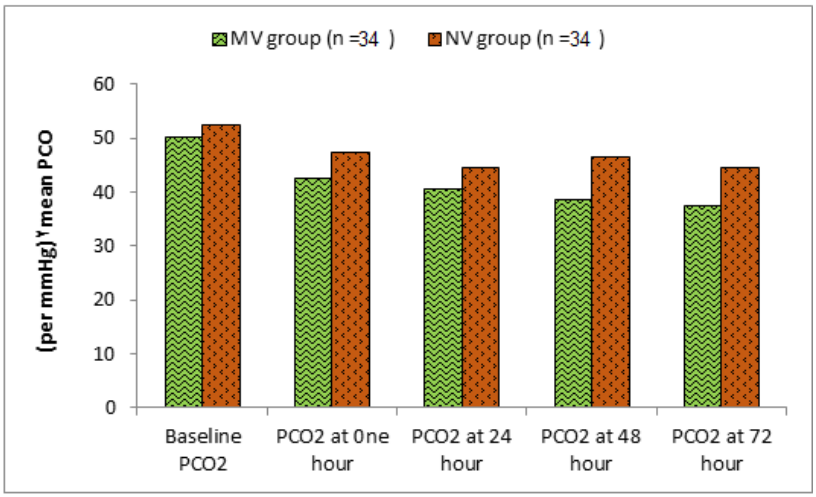

Figure 4 A comparison between both the MV group and the NV group in terms of mean pCO2 through different time periods per mmHg.

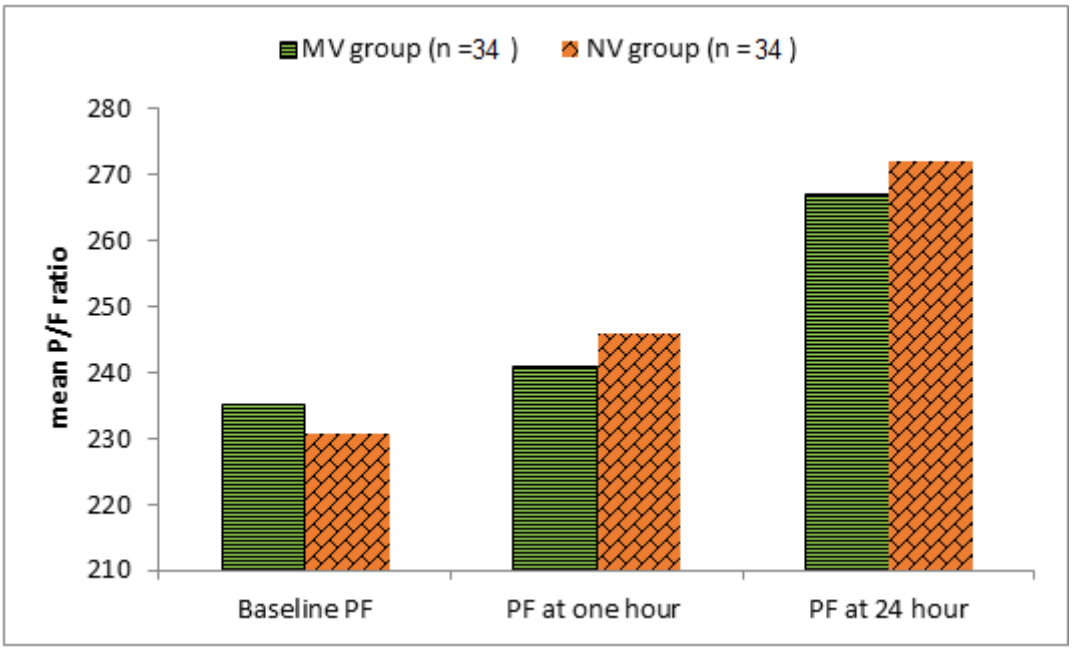

Figure 5 A comparison between both the MV group and the NV group in terms of mean P/F ratio at different time intervals.

4. DISCUSSION

The management of ventilation has two objectives: the first is to prevent the development of lung injury associated with ventilation to ARDS or MOFS and the second is to support the respiratory system. The internal stability of the chest wall requires continuous mechanical ventilation (Schreiber et al., 2018). There are two methods of ventilation: invasive and non-invasive in the case of hypoxia of the respiratory system have been mentioned by Prunet et al. (2019). They also noted that the short duration of stay in ICU as well as the lack of complications associated with NIV.

In our current study, stay in ICU was higher in group MV group than in the NV group, and in the complication rate, it was increased. Bhattacharya & Davis., 2018 reported in a previous study that the distance from anesthesia, analgesia and avoid intubation complications and ease of return and removal and effectiveness in the case of low oxygen and respiratory failure, it reduces the rate of intubation and mortality. Studies on ventilation management of patients are few, especially for those with oxygen deficiency and post-traumatic respiratory failure (Peña-López et al., 2018). The British Thoracic Society of Multiple Trauma Patients was recommended for low quality based on C level available for NIV use and no recommendations for non-invasive ventilation were made by the Canadian Critical Care Association (Ni et al., 2018). Frat et al. 2019 in a prospective study indicated that the rate of pulmonary complications decreased significantly due to little use of mechanical ventilation in the CPAP group. Rochwerg et al. (2017) showed a significant decrease in both the mortality rate and the hospital infection rate in the CPAP group. However, the duration of stay in different intensive care and the small number of patients enrolled in the study raised concerns about generalization (Frat et al ., 2019). Our results are in agreement with the results obtained by Mishra et al. 2019, they pointing out that the use of NIV reduces deaths, damages, and complications as well as the length of stay in intensive care, which leads to low cost.

5. CONCLUSION

We conclude from our study that artificial respiration has effective strategies and may be the best choice between the two strategies. The mean HH, HR, pO2, pCO2 and P/F ratio were improved in the MV group as well as in the NV group but this improvement were not significant. The use of noninvasive ventilation reduces mortality, damages, and complications as well as the length of stay in intensive care (ICU), which leads to low-cost.

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List of abbreviations

(MV) Mechanical Ventilation
(NV) Noninvasive Ventilation
(ICU) Intensive Care
(pO2) Pressure oxygen
(pCO2) Pressure Carbon-di-oxide
(PT) Pneumothorax;
(HT) Hemothorax
(HPT) Hemopneumothorax
(GCS) Glasgow coma scale score
(RR) Respiratory rate
(HR) Heart rate
(MAP) Montpellier Antiphospholipid
(SpO2) Peripheral Capillary Oxygen Saturation

Ethical considerations

Ethical permission has been taken from the Ethical committee of Zagazig University Hospital.

Funding

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Conflict of interest

The authors declare that they have no conflict of interest.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study.

Data and materials availability

All data associated with this study are present in the paper.

Peer-review

External peer-review was done through double-blind method.

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