

# Effect of Neck Collar Fixation on Ventilation in Multiple Trauma Patients

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## Abstract

**Background:** According to the guidelines for treatment of multiple trauma patients, immobilization of the neck and neck collar fixation are essential. However, following neck collar fixation patients usually experience dyspnea. Some studies have found that neck collar fixation can lead to decreased pulmonary volumes, yet there have been no studies on the effect of neck collar fixation on patient ventilation.

**Objectives:** The purpose of this study was to determine the effect of neck collar fixation on ventilation in multiple trauma patients.

**Methods:** This study was a descriptive-analytical study, which was performed in the emergency department of Tabriz University of Medical Sciences on multiple trauma patients with a Glasgow Coma Score (GCS) of 15. The effect of neck collar fixation on ventilation in the study participants was examined with the use of capnography.

**Results:** This study involved 163 multiple trauma patients. Of these, 65% were male. The mean of end tidal carbon dioxide (ETCO<sub>2</sub>) of the patients without neck collars was 34.62 ± 4.46 and the mean ETCO<sub>2</sub> of the patients with neck collars was 34.21 ± 2.31. There was no significant difference between the means of ETCO<sub>2</sub>, before and after removing the neck collar, among the studied patients (P = 0.196).

**Conclusions:** According to the results of our study, neck collar fixation has no effect on ventilation in multiple trauma patients.

**Keywords:** Capnography, Multiple Trauma, Ventilation

## 1. Background

Accidents and trauma can lead to physical and psychological harm, as well as to disinvestment and economic losses (1). Trauma resulting from car accidents kills about 1.2 million people annually and causes more than 50 million injuries or disabilities. Iran, with 30 deaths per one hundred thousand people, has the highest rate of car accident fatalities in the world (2, 3). Spinal cord injuries account for 4.8% of all trauma-related injuries, and half of these are neck spine injuries. Car accident-induced injuries are one of the main types of neck injuries, followed by falling from height, being shot and sports injuries (4).

The criteria for pre-hospital spinal immobilization has been transformed with the development of emergency medical systems. The American academy of orthopedic surgeons has emphasized the symptoms of potential spinal cord injury (5). Evaluation of the neck spine should be performed at the scene simultaneously with airway control, and a neck collar must be fixed (6). Use of a long backboard, sand bags and Kendrick removing equipment are

necessary to stabilize the spine (7, 8).

It seems that most patients complain of feeling shortness of breath on a backboard and have a tendency to remove the collar or get off the backboard (5). Studies conducted on the effects of neck collar fixation on the pulmonary functions of trauma patients have concluded that the neck collar will lead to a significant decrease in patients' pulmonary volumes (5), but the studies have not examined the effect of a neck collar on ventilation in trauma patients. Currently, capnography is used to evaluate ventilation in clinical wards. Capnography produces the a value for end tidal carbon dioxide (ETCO<sub>2</sub>) and can precisely monitor a patient's ventilation status (9, 10). Given the above, it appears that use of a ventilation monitor in multiple trauma patients, especially with a neck collar, is necessary.

## 2. Objectives

Our study was aimed at determining the effects of neck collar fixation on ventilation in multiple trauma patients by using capnography. In addition, this study compared the values of ETCO<sub>2</sub>, O<sub>2</sub>Sat, and respiratory rate (RR) before and after removing the neck collar.

## 3. Methods

This study was a descriptive-analytical study that was performed in the emergency department (ED) of Imam Reza medical research and training hospital, Tabriz, East Azerbaijan, Iran. The hospital has 110,000 admissions per year, and the study was conducted during a 7-month period (December 2013 - June 2014) on multiple trauma patients with a Glasgow Coma Score (GCS) of 15. Using capnography, the study examined the effect of neck collars on the ventilation in these patients. The study was verified by the ethics committee of Tabriz University of Medical Sciences (No. 92150). Informed consent was obtained from each patient included in the study.

A literature search was performed, and the authors were not able to find any similar studies. The sample size was initially determined to be 150, but finally, 163 patients were included in the study. The inclusion criteria were patients aged 18 - 65 years who were referred to the ED of Imam Reza hospital. The exclusion criteria of the study were a history of smoking, lung diseases, chest trauma, GCS ≤ 14, unstable vital signs, failure to cooperate with the project and unwillingness to participate in the study. The vital signs of all participants were monitored and recorded after obtaining ethical consent. Then, while the patients had a neck collar, pulse oximetry was performed with a pulse oximetry device (model number: 101N, Respironics, California Inc., California, USA) and capnography was conducted with a capnography device (model number: 7100, Respironics, California Inc., California, USA). After performing the necessary treatments for trauma, and while ensuring the safety of the patient's neck spine, the neck collar was removed. Ten minutes after removing the neck collar, capnography, pulse oximetry and respiratory rate (RR) per minute were recalculated and all results were recorded.

To analyze the results, we used the SPSS 17.0 statistical application. To determine the normal distribution of data, the Kolmogorov-Smirnov test was used. Data description was performed using the descriptive tests (mean ± SD) and to compare the mean of quantitative data before and after removing the collar, the paired samples t test was used. A P value of less than 0.05 was considered significant in all analyses.

## 4. Results

In this study, we evaluated 163 trauma patients, before and after removing the neck collar, using capnography. Of the total patients, 106 (65%) were male. The mean age of the male group was 38.28 ± 14.96 years and for the female group it was 37.28 ± 14.70 years. There was no significant difference between the mean ages of both sexes (P = 0.682). Table 1 shows the vital signs means of the studied patients.

**Table 1.** Patients' Vital Signs at the Time of First Admission to the Emergency Department

Variables	Mean ± SD
<b>Vital Signs</b>	
Systolic Blood Pressure	117.12 ± 22.56
Systolic Blood Pressure	73.89 ± 14.52
Heart Rate	83.24 ± 12.45
Respiratory Rate	17.69 ± 3.90
ETCO <sub>2</sub>	34.21 ± 2.31
O <sub>2</sub> sat	95.56 ± 1.70

The ETCO<sub>2</sub> mean, which was obtained with the capnography device before removing the neck collar, was 34.62 ± 4.46, and after removal it was 34.21 ± 2.31. There was no significant difference between the ETCO<sub>2</sub> mean of patients with capnography before and after removing the neck collar (P = 0.196). The mean of respiratory rate before removing the neck collar was 16.82 ± 6.89, and after taking it off it was 17.69 ± 3.90. There was no significant difference between the means of patient respiratory rate with capnography, before and after removing the neck collar (P = 0.055). The mean of O<sub>2</sub> saturation (O<sub>2</sub>Sat) before removing the neck collar was 95.45 ± 3.08, and after taking it off it was 95.56 ± 1.70. There was no significant difference between the mean of O<sub>2</sub>sat with pulse oximetry before and after removing the neck collar (P = 0.593). Table 2 shows the results of the ventilation status before and after removing the neck collar.

**Table 2.** Results of Data Comparison (RR, ETCO<sub>2</sub> and O<sub>2</sub>sat) Before and After Removing of Neck Collar

	Before	After	P Value
ETCO <sub>2</sub>	34.21 ± 2.31	34.62 ± 4.46	0.196
RR	17.69 ± 3.90	16.82 ± 6.89	0.055
O <sub>2</sub> sat	95.56 ± 1.70	95.45 ± 1.70	0.593

## 5. Discussion

Trauma is one of the factors that causes death in young people and in workplaces around the world (2). Trauma guidelines state that neck fixation with a collar is necessary in the early stages of evaluation of trauma patients. However, it seems that the majority of patients complain about feelings of dyspnea on a backboard, or because of having a neck collar, and have a tendency to remove the collar or depart from the backboard (5). Managing the respiratory status and level of tissue oxygenation is important in treating trauma patients in the emergency department and should be one of the first steps in patient evaluation. Urgent action should be taken to improve respiratory status, and taking care of the neck spine of trauma patients is essential before any diagnostic intervention (11, 12).

In a study performed by Ay et al., which used spirometry to analyze the effect of neck spine immobilization on pulmonary function in healthy individuals, the authors suggested that the use of a neck collar would cause a significant decrease in spirometry parameters in patients (13). In another study, Bauer et al. evaluated the effect of neck collar fixation on spirometry parameters and stated that using a neck collar caused a significant decrease in the rate of FVC, FEV1 and FEF25 - 75 (14). In a study done by Schafermeyer et al., in which they evaluated the effect of neck collar fixation on pulmonary function in children, the authors showed that the use of a neck collar in children causes a significant decrease in pulmonary function parameters (15). In another study, Legg et al. compared spirometry parameters in patients with and without neck collars and suggested that neck collar fixation significantly reduces the rate of FVC, at a rate of 3.94% (16). Bygrave et al. evaluated the effect of using a neck collar on pulmonary function using spirometry and stated that neck collar fixation causes a significant decrease in spirometry parameters, showing values of FVC with 3.6%, FEV1 with 4.3% and FEF25 - 75 with 4.8%, with neck collar fixation (17). In a study conducted by Totten et al., it was found that in 39 patients with neck collars there was an average reduction of 15% in pulmonary capacities and spirometry (18). According to the results of our study, it was determined that fixation with a neck collar had no significant effect on ventilation and oxygenation of the patients in our study.

The limitations of this study included uncooperative patients, such as in cases of agitated patients or patients with severe pain. Also, according to the study criteria, patients with a brief loss of consciousness or respiratory distress have not been studied.

Based on the study results, it is clear that neck collar fixation has no effect on ventilation or oxygenation in multiple trauma patients. However, further studies should be

conducted to confirm these results. This study concludes that the effect of neck collar fixation on pulmonary function tests is due to the need for use of force and of the accessory muscles of respiration to perform these tests, and that the activities of these muscles would probably be limited by the neck collar fixation. However, normal ventilation would not require the use of force and accessory muscles, and as a result we conclude that the neck collar had no effect on ventilation.

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## Footnote

**Authors' Contribution:** All authors have read and approved the manuscript. Farzad Rahmani, Mahboob Pouraghaei and Ebrahim Mashhadi performed the data collection, literature review and drafting of the manuscript. Payman Moharamzadeh undertook the major parts of the study design and performed the statistical analysis

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