

Predictors of chest drainage complications in trauma patients

Fatores preditores de complicações da drenagem de tórax em pacientes vítimas de trauma

CECÍLIA ARAÚJO MENDES¹; ELCIO SHIYOITI HIRANO, TCBC-SP²

ABSTRACT

Objective: to identify predictors of chest drainage complications in trauma patients attended at a University Hospital. **Methods:** we conducted a retrospective study of 68 patients submitted to thoracic drainage after trauma, in a one-year period. We analyzed gender, age, trauma mechanism, trauma indices, thoracic and associated lesions, environment in which the procedure was performed, drainage time, experience of the performer, complications and evolution. **Results:** the mean age of the patients was 35 years and the male gender was the most prevalent (89%). Blunt trauma was the most frequent, with 67% of cases, and of these, 50% were due to traffic accidents. The mean TRISS (Trauma and Injury Severity Score) was 98, with a mortality rate of 1.4%. The most frequent thoracic and associated lesions were, respectively, rib fractures (51%) and abdominal trauma (32%). The mean drainage time was 6.93 days, being higher in patients under mechanical ventilation ($p=0.0163$). The complication rate was 26.5%, mainly poor drain positioning (11.77%). Hospital drainage was performed in 89% of cases by doctors in the first year of specialization. Thoracic drainage performed in prehospital care presented nine times more chances of complications ($p=0.0015$). **Conclusion:** the predictors of post-trauma complications for chest drainage were a procedure performed in an adverse site and mechanical ventilation. The high rate of complications demonstrates the importance of protocols of care with the thoracic drainage.

Keywords: Thoracic Injuries. Drainage. Postoperative Complications.

INTRODUCTION

Chest trauma is present in 10% to 15% of the traumatized, accounting for 25% of all deaths¹, mainly due to airway and ventilation compromise. Ventilation may be altered by isolated or associated thoracic injuries, such as hemothorax, pneumothorax, pulmonary contusion, costal arch fractures, and intercostal vessel lesions. In the first two examples, the treatment is mostly represented by closed chest drainage, a small surgical procedure that can be performed even in Prehospital Care (PHC)²⁻⁴. It is important to note that less than 10% of blunt thoracic trauma and less than 30% of penetrating trauma will

require larger surgery⁵.

Properly performed chest seal drainage is a safe procedure and about 80% of patients have adequate resolution^{5,6}. Complications, when they occur, can be caused by two factors: a) technical, due to lack of knowledge of the thoracic anatomy, inadequate training, lack of experience or deficiency of supervision, when performed by a physician in training; and b) infectious, when the procedure is performed in an inappropriate environment or without due asepsis and antisepsis⁷.

This study aims to identify predictive factors related to the complications of thoracic drainage in trauma patients, correlating them with the literature.

1- Campinas State University, Discipline of Trauma Surgery, Faculty of Medical Sciences, Campinas, SP, Brazil. 2 - Campinas State University, Post-Graduate Program, Master's Degree in Surgery Sciences, Faculty of Medical Sciences, Campinas, SP, Brazil.

METHODS

This is a descriptive, analytical and retrospective study of 68 trauma patients who underwent closed chest drainage in water seal, in the PHC or in the Emergency Unit of the Clinics Hospital (CH) of the State University of Campinas (Unicamp), in the period from April 2013 to April 2014. We excluded Patients younger than 14 years. We requested waiver of the informed consent form, in accordance with Resolution nº 196, of the Code of Medical Ethics. The opinion was approved by the Ethics in Research Committee under number 474339.

We analyzed the variables gender, age, trauma mechanism, trauma indices, drainage time, associated injuries, graduation level of the physician who performed the procedure, drainage environment, complications and clinical evolution.

The data were analyzed by Unicamp's FCM Biostatistics Service, which used the software Statistical Analysis System for Windows (SAS), version 9.4. SAS Institute Inc., 2002-2008, Cary, NC, USA⁸⁻¹⁰.

RESULTS

Of the 68 patients studied, 89% were male, with an average age of 35 years. The Revised Trauma Scores (RTS) had a median of 7.84 and the Trauma and Injury Severity Score (TRISS), of 98. The predominant trauma mechanism was the blunt one (67% of cases), the motorcycle event being the most prevalent, with 22%. Penetrating gunshot and stabbing injuries accounted for 16% of individual cases. When grouped together, the traffic events (motorcycling accidents, automobile accidents and running over) corresponded to 50% of the casuistry.

Isolated thoracic lesions occurred in 14 patients, and the most frequent associated lesion was abdominal trauma, in 32% of cases, followed by head trauma and long bone fractures, each with 10%. The involvement of more than two body segments was present in 26% of the patients. Pulmonary contusion and rib fracture were the most frequent thoracic injuries (Figure 1).

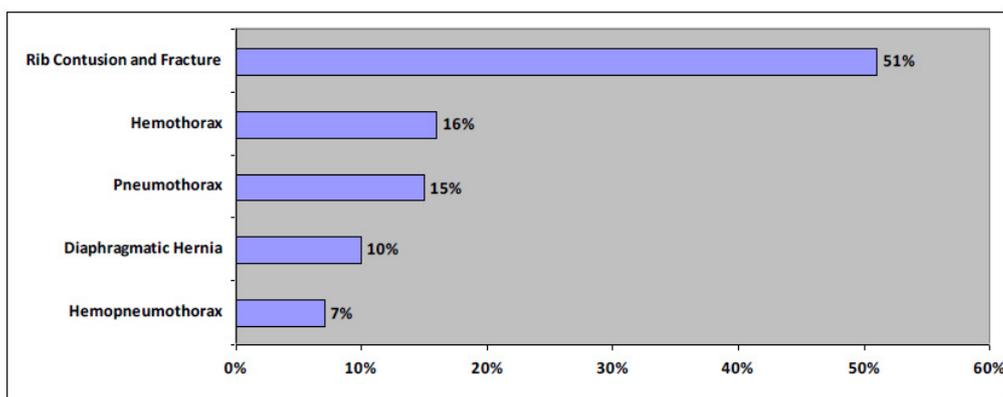


Figure 1. Most frequent thoracic lesions.

Bilateral thoracic drainage was performed in 19% of cases. The duration of the drain ranged from one to 19 days, with a mean of 6.93 days. Patients who required mechanical ventilation remained longer with thoracic drainage, with statistical significance, $p=0.0163$. In 56 patients, thoracic drainage was carried out in a hospital setting, and in 89% (50 patients), performed by physicians in the first year of surgical specialization.

The thoracic drainage rate in the PHC setting was 17.6% (12 patients), and presented a risk of complications nine times higher when compared to those performed in

a hospital environment, with $p=0.0015$ (Table 1).

Table 1. Incidence of complications after thoracic drainage according to the environment where it was performed.

Environment	Complications	
	No (n/%)	Yes (n/%)
Hospital (n=56)	46 / 82.1	10 / 17.9
PHC* (n=12)	4 / 33.3	8 / 66.7
Total (n=68)	50 (73.5)	18 (26.5)

*PHC: Prehospital Care.

The overall complication rate was 26.5% (18 patients), and the malposition of the drain, with the need for new drainage, was the most frequent complication, with eight cases (Table 2). These occurred due to the position of the last drain hole outside the pleural cavity (n=4) and due to drainage introduced into the subcutaneous (n=2) or into the abdominal cavity (n=2).

Table 2. Complications of thoracic drainage.

Complications	Cases	%
Residual Hemothorax	2	2.9
Residual Pneumothorax	3	4.4
Pneumonia	5	7.4
Re-drainage	8	11.8
Total	18	26.5

Thoracoscopy was indicated in two patients: one for empyema (gastric perforation by the drain in one patient with traumatic diaphragmatic hernia) and another for residual hemothorax. The empyema patient evolved with incarceration and the need for pleurostomy.

The mean length of hospital stay was 20 days. One death (1.5%) occurred due to multiple complications and the severity of the associated lesions.

DISCUSSION

Urban violence predominates in developing countries. In Brazil the death rate due to homicides in the age group of 15 to 29 years is 20 times higher than the rate of European countries¹¹. In a study of the University Hospital in Damascus, Syria, with 888 patients with thoracic trauma, traffic accidents were the main cause, in areas outside the conflict zones. Accidents were the most frequent mechanism (40% of cases), male gender was the most prevalent (89% of cases), mean age was 31 years and associated lesions occurred in 36% of patients, with predominance of upper and lower limbs (19% of cases), followed by abdominal and craniocerebral trauma (13% and 8% of the cases, respectively)¹². This differs from our study, in which abdominal trauma was the lesion most

associated with thoracic trauma (32 % of cases) and the most prevalent event was motorcycling.

The Revised Trauma Score (RTS) is a physiological index of the patient at admission, based on three parameters: neurological level (Glasgow Coma Scale – GCS), systolic blood pressure and respiratory rate, the higher the value, the better the prognosis. The Injury Severity Score (ISS) is an anatomical index that classifies the severity of the lesions in each body segment. Trauma and Injury Severity Score (TRISS) is an index that demonstrates the probability of survival of the traumatized individual and is calculated by the association between RTS, ISS, patient age and type of trauma (blunt or penetrating). In the present study, 77.9% of the cases presented RTS between 5 and 8, with a survival probability of 80%. The median of the TRISS was 0.98, compatible with the low mortality of 1.4%.

The complication rate of 26.5% was due to poorly positioned drains and residual hemothorax and pneumothorax, which may also be related to drains that are poorly positioned in the pleural cavity, folded or directed to the diaphragm, which makes it difficult for air and liquids to escape. Residual hemothorax occurred in 2.9% of our cases and the treatment was performed by thoracoscopy. Post-trauma residual hemothorax in the work of Navsaria *et al.* occurred in 4.4% of patients submitted to thoracic drainage. Video-assisted thoracoscopic surgery (VATS) was successful in the hygiene of the pleural space in 80% of cases and failed in 20% due to the presence of pulmonary incarceration, requiring thoracotomy¹³. A study by Rezende Neto *et al.* emphasizes that residual hemothorax contributes to an increase in hospitalization time, costs and morbidity, the infectious complication being 12 to 16 times more frequent¹⁴. The definition and diagnosis of retained hemothorax are not consensus, a fact that often leads to delayed treatment, increasing the chances of infectious complications, prolonging hospital stay and drainage time.

At the trauma center at the University of Medical Sciences in Iran, Abbasi *et al.* demonstrated that it is safe to withdraw the drain in patients under mechanical ventilation, provided that the following criteria are met: flow rate less than 300 milliliters in 24 hours, absence

of air leakage and radiographic examination with pulmonary expansion. They also point out that drainage withdrawal reduces morbidity, complications and reduces hospitalization time¹⁵. The criteria used in the Discipline of Trauma Surgery – Unicamp for the removal of the post-traumatic chest drain are: flow less than 100 milliliters in 24 hours, absence of air leakage, full lung expansion by simple chest X-ray and physical examination. The present study demonstrated that drainage withdrawal in patients under mechanical ventilation was late, with statistical significance ($p=0.0163$).

Aylwin *et al.* evaluated the thoracic drainage performed in PHC and in the hospital by a trauma team according to the ATLS precepts. A sample of 57 patients presented an overall complication rate of 14%. Of these 31% were by poorly positioned tubes, and 17% had to be submitted to a new drainage. They concluded that there was no difference in the risk of drainage complications in the PHC and in-hospital, and that the in-hospital complication rates due to failures in the technique were high, which called attention to the adequate formation and training of the team¹⁶. In the present study, 17.6% were drained in the PHC, one case being in a primary health unit. This group of patients had a nine-fold greater risk of complications than the group submitted to thoracic drainage in our Service, with $p=0.0015$. The PHC environment is adverse and several local and external factors may contribute to the increase in the rate of complications, such as site contamination, climatic variation (rain, wind), inadequate positioning, and limited material and resources.

Kesieme *et al.* performed an evaluation among surgery resident physicians of the first year on anatomical points to perform thoracic drainage and revealed that 45% did not identify the correct site, the most common error being the very low insertion error (20%). They concluded that these are avoidable complications¹⁷. A study involving four teaching hospitals in Nigeria evaluated the level of resident doctors' experience and knowledge in thoracic drainage and found that 10% of the interviewees had never performed the procedure, and 77% performed it for the first time in the first year of residence training. He also identified that 40% had never placed the chest drain in connection with continuous aspiration. Only 30% examined the patient again and

gave a simple chest X-ray examination after drainage. They concluded that, since this is a simple and salvage procedure in critical situations, the training of medical surgeons should be done at the beginning of the surgical career, with adequate supervision¹⁸. In the present study, 89% of in-hospital drainage was performed by a resident physician in the first year of surgical specialization. There was no statistical relation of greater complications between this group and the one drained by doctors with higher level of experience.

In 2015, the impact of a protocol of Standardized Care with the Chest Drain (Cuidado Padronizado com o Dreno de Tórax – CPDT) in a public hospital, a reference for trauma in the city of Belo Horizonte/ Brazil, was evaluated as part of the Trauma Care Quality Improvement Program. The studied group presented an isolated lesion of the chest wall, lung and/or pleura, was hemodynamically stable and had an ISS inferior to 17. The implementation of CPDT was effective in the reduction of complications: significant reduction ($p<0.05$) of retained hemothorax, empyema, pneumonia, wound infection, length of hospital stay, and drain permanence. Respiratory physiotherapy attendance raised from 1% to 96% of patients, drainage in the surgical center, from 59% to 75%, and prophylactic antibiotic use, from 31% to 54%. The group receiving physical therapy twice a day had a 79% lower chance of retained hemothorax. Drainage in the surgical center was associated with reduced empyema, pneumonia and surgical wound infection. The study emphasizes that pleuropulmonary complications prior to the implementation of CPDT did not meet acceptable international parameters, ranging from 11% to 31%, and that there was a decline to 6.5%¹⁹.

Prehospital drainage, trauma mechanism, need for mechanical ventilation and injuries in other body segments are some of the predictors of chest drainage complications observed in the present study and listed in the literature¹². These are variables that reveal the severity of the patient and the need for specific care. Therefore, the understanding of these variables will influence the management and evolution of patients submitted to thoracic drainage.

The mortality rate in patients hospitalized for isolated chest injury is between 4% and 8%. When there

is another body segment involved, it increases to 10% to 25%, and reaches 35% when there is compromise of multiple organ systems²⁰. In the present study, 18 patients (26%) presented lesions in more than two body segments, and one death occurred due to multiple organ lesions.

We conclude that the predictive factors of

complications of post-traumatic thoracic drainage were adverse site to perform the procedure, such as in the prehospital care setting, and mechanical ventilation, which determines a longer drainage time. Our complication rate is close to the upper limit of the literature, which demonstrates the importance of elaborating care protocols with patients submitted to thoracic drainage.

R E S U M O

Objetivo: identificar fatores preditores de complicações da drenagem torácica em pacientes vítimas de trauma, atendidos em um Hospital Universitário. **Métodos:** estudo retrospectivo de 68 pacientes submetidos à drenagem torácica pós-trauma, no período de um ano. Foram analisadas as seguintes variáveis: sexo, idade, mecanismo de trauma, índices de trauma, lesões torácicas e associadas, ambiente em que foi realizado o procedimento, tempo de permanência do dreno, grau de experiência do executor do procedimento, complicações e evolução. **Resultados:** a média de idade dos pacientes foi de 35 anos e o sexo masculino foi o mais prevalente (89%). O trauma contuso foi o mais frequente, com 67% dos casos, e destes, 50% por acidentes de trânsito. A média do TRISS (Trauma and Injury Severity Score) foi 98, com taxa de mortalidade de 1,4%. As lesões torácicas e associadas mais frequentes foram, respectivamente, fraturas de costelas (51%) e trauma abdominal (32%). A média de permanência do dreno foi de 6,93 dias, sendo maior nos pacientes sob ventilação mecânica ($p=0,0163$). A taxa de complicações foi de 26,5%, com destaque para o mau posicionamento do dreno (11,77%). A drenagem hospitalar foi realizada, em 89% dos casos, por médicos do primeiro ano de especialização. A drenagem torácica realizada no atendimento pré-hospitalar apresentou nove vezes mais chances de complicações ($p=0,0015$). **Conclusão:** os fatores preditores de complicações para drenagem torácica pós-trauma foram: procedimento realizado em local adverso e ventilação mecânica. A alta taxa de complicações demonstra a importância dos protocolos de cuidados com a drenagem torácica.

Descritores: Traumatismos Torácicos. Drenagem. Complicações Pós-Operatórias.

REFERENCES

- Oikonomou A, Prassopoulos P. CT imaging of blunt chest trauma. *Insights Imaging*. 2011;2(3):281-95.
- Calhon JH, Trinkle JK. Pathophysiology of chest trauma. *Chest Surg Clin N Am*. 1997;7(2):199-211.
- Silas MG, Belluzzo GR, Miguel EG, Bahdur R, Pires AC. Traumatismos torácicos: análise de 231 casos. *Arq Med ABC*. 1990;13(1-2):19-21.
- Symbas PN. Chest drainage tubes. *Surg Clin North Am*. 1989;69(1):41-6.
- Block EF, Kirton OC, Windsor J, Kestner M. Guided percutaneous drainage for posttraumatic empyema thoracics. *Surgery*. 1995;117(3): 282-7.
- Dural K, Gulbahar G, Kocer B, Sakinci U. A novel and safe technique in closed tube thoracostomy. *J Cardiothorac Surg*. 2010;5:21.
- Kesieme EB, Dongo A, Ezemba N, Irekpita E, Jebbin N, Kesieme C. Tube thoracostomy: complications and its management. *Pulm Med*. 2012;2012: 256878.
- Conover WJ, Iman RL. Rank transformations as a bridge between parametric and nonparametric statistics. *Am Stat*. 1981;35(3):124-9.
- Fleiss JL. *Statistical methods for rates and proportions*. 2nd ed. New York: John Wiley & Sons; 1981.
- Montgomery DC, Peck EA. *Introduction to linear regression analysis*. New York: John Wiley & Sons; 1982.
- Brasil. Ministério da Saúde. Organização Pan-Americana da Saúde. Rede Interagencial de Informações para Saúde. Demografia e saúde: contribuição para análise de situação e tendências. Brasília: Organização Pan-Americana da Saúde; 2009.
- Al-Koudmani I, Darwish B, Al-Kateb K, Taifour Y. Chest trauma experience over eleven-year period at al-Mouassat university teaching hospital-Damascus: a retrospective review of 888 cases. *J Cardiothorac Surg*. 2012;7:35.
- Navsaria PH, Vogel RJ, Nicol AJ. Thoracoscopic evacuation of retained posttraumatic hemothorax. *Ann Thorac Surg*. 2004;78(1):282-5; discussion 285-6.

14. Rezende Neto JB, Pastore Neto M, Hirano ES, Rizoli S, Nascimento Júnior B, Franga GP. Abordagem do hemotórax residual após a drenagem torácica no trauma. *Rev Col Bras Cir.* 2012;39(4):344-9.
15. Abbasi HR, Farrokhnia F, Sefidbakht S, Paydar S, Bolandparvaz S. Chest tube removal time in trauma patients on positive ventilation pressure: a randomized clinical trial. *Bull Emerg Trauma.* 2013;1(1):17-21.
16. Aylwin CJ, Brohi K, Davies GD, Walsh M. Pre-hospital and in-hospital thoracostomy: indications and complications. *Ann R Coll Surg Eng.* 2008; 90(1):54-7.
17. Kesieme EB, Olusoji O, Inuwa IM, Ngene CI, Aigbe E. Management of chest drains: a national survey on surgeons-in-training experience and practice. *Niger J Surg.* 2015;21(2):91-5.
18. Abreu EMS, Machado CJ, Pastore Neto M, Rezende Neto JB, Sanches MD. Impacto de um protocolo de cuidados a pacientes com trauma torácico drenado. *Rev Col Bras Cir.* 2015;42(4):231-7.
19. Fontelles MJP, Mantovani M. Trauma torácico: fatores de risco de complicações pleuropulmonares pós drenagem pleural fechada. *Rev Col Bras Cir.* 2000;27(6):400-7.

Received in: 23/11/2017

Accepted for publication: 09/01/2018

Conflict of interest: none.

Source of funding: none.

Mailing address:

Elcio Shiyoi Hirano

E-mail: hirano.es@gmail.com /

ceciliaaraujomendes@gmail.com

