

## ORIGINAL RESEARCH

# Pneumothoraces on Computed Tomography Scan: Observation using the 35 Millimeter Rule is Safe

<sup>1</sup>Catrina Cropano, <sup>2</sup>Tomaz Mesar, <sup>3</sup>David Turay, <sup>4</sup>David King, <sup>5</sup>Daniel Yeh, <sup>6</sup>Peter Fagenholz  
<sup>7</sup>George Velmahos, <sup>8</sup>Marc A de Moya

## ABSTRACT

**Introduction:** The management of a pneumothorax (PTX) either by observation or with a tube thoracostomy (TT) has long been dictated by practitioner discretion rather than objective criteria. Many physicians elect to routinely place a TT for traumatic PTX, particularly when patients undergo positive pressure ventilation (PPV). Placement of unnecessary TT exposes patients to avoidable morbidity and may prolong hospitalization. Based on prior work establishing a cutoff, we hypothesized that all PTXs  $\leq 35$  mm in patients who have no physiologic derangement may be safely observed without TT regardless of the need for PPV.

**Materials and methods:** Retrospective review of all patients diagnosed with a PTX between 1/2009 and 2/2013. All PTXs visible on chest computed tomography (CT) were identified. Any patient with an associated significant hemothorax or those patients who were moribund were excluded. All PTXs were measured by measuring the perpendicular distance of the largest air pocket between the chest wall and the mediastinal or pulmonary structure. Management of the PTX was categorized as observation or TT. Observed PTXs were labeled as success or failure with failure defined as enlargement of the PTX or physiologic deterioration, requiring a TT.

**Results:** Out of 165 PTXs, 17 (10.3%) measured  $>35$  mm, whereas 148 (89.7%) measured  $\leq 35$  mm. Of the 17  $>35$  mm, 15 (88.2%) received immediate TT. Of the two PTXs  $>35$  mm which were observed, one received a delayed TT for a pleural effusion (6 days after PTX diagnosis) and one (5.9 %) was safely observed. Of the 148 PTXs which measured  $\leq 35$  mm, 10 (6.8%) received immediate TT. Of the 138 remaining PTXs, 129 (93.5%) were safely managed without TT. Six (4.3%) of the PTXs initially observed eventually required TT placement for enlargement of the PTX. Only one of those six had manifested ongoing desaturations prior to TT. The remaining three cases received TT for reasons unrelated to the PTX. Of the 27 PPV cases in the  $\leq 35$  mm cohort, none contributed to the six failures. A cutoff measurement of 35 mm demonstrated a

negative predictive value (NPV) of 95.7% in its ability to predict successful observation of the PTX with an area under the receiver operating characteristic (ROC) curve of 0.90.

**Conclusion:** All PTXs measuring  $\leq 35$  mm perpendicular to the chest wall without physiologic derangement may be safely observed independent of the need for mechanical ventilation.

**Keywords:** Chest tube, Drainage, Pneumothorax.

**How to cite this article:** Cropano C, Mesar T, Turay D, King D, Yeh D, Fagenholz P, Velmahos G, de Moya MA. Pneumothoraces on Computed Tomography Scan: Observation using the 35 Millimeter Rule is Safe. Panam J Trauma Crit Care Emerg Surg 2015;4(2):48-53.

**Source of support:** Nil

**Conflict of interest:** None

## RESUMEN

**Introducción:** El manejo del neumotórax, ya sea con observación clínica o con sonda pleural, se ha basado en el juicio clínico y no en criterios objetivos.

Muchos prefieren utilizar la sonda pleural de manera rutinaria para los pacientes con un neumotórax traumático, especialmente cuando están bajo ventilación mecánica con presión positiva. La utilización de sonda pleural de manera innecesaria y excesiva expone a los pacientes a importante morbilidad y podría incluso prolongar el tiempo de hospitalización. Algunos estudios previos han establecido un punto de corte y, basándonos en esto, nuestra hipótesis es que todos los pacientes con un neumotórax mayor a 35 mm, sin ninguna alteración fisiológica, pueden ser observados clínicamente sin el uso de sonda pleural, a pesar de que se necesite utilizar ventilación mecánica con presión positiva.

**Materiales y métodos:** Realizamos un estudio retrospectivo de todos los pacientes con diagnóstico de neumotórax entre enero del 2009 y febrero del 2013. Todos los pacientes con neumotórax visible en la tomografía computarizada fueron identificados. Los pacientes con hemothorax o clínicamente graves fueron excluidos. Para medir los neumotórax utilizamos la distancia perpendicular entre la pared torácica y el mediastino o pulmón y la bulla de aire más grande.

El manejo de los pacientes se categorizó en observación clínica o uso de sonda pleural. Definimos el tratamiento como exitoso o fallido; si el neumotórax creció o hubo algún deterioro fisiológico del paciente que finalmente requirió el uso de sonda pleural, fue considerado como fallido.

<sup>1-3</sup>Research Assistant, <sup>4-6</sup>Assistant Professor, <sup>7</sup>Professor  
<sup>8</sup>Associate Professor

<sup>1-8</sup>Department of Surgery, Massachusetts General Hospital  
 Boston, MA, USA

**Corresponding Author:** Marc A de Moya, Department of Surgery, Massachusetts General Hospital, 165 Cambridge Street, Suite 810, Boston MA 02114, USA, Phone: 1-617-724-4121, e-mail: mdemoya@partners.org

Note: Paper presented in General Research Competition at the annual congress of Panamerican Trauma Society, Panama City, Panama, November 2015.



**Resultados:** De un total de 165 pacientes con neumotórax, 17 (10.3%) midieron >35 mm y 148 (89.7%) midieron <35 mm. De los 17 >35 mm, 15 (88.7%) fueron tratados inmediatamente con sonda pleural. Los dos pacientes que fueron observados, uno fue tratado con sonda pleural (6 días después del diagnóstico) y el otro fue observado sin ninguna complicación. De los 148 que midieron <35 mm, 10 fueron tratados inmediatamente con sonda pleural. De los 138 restantes, 129 (93.5%) fueron tratados exitosamente sin sonda pleural. Seis (4.3%) de los pacientes que fueron inicialmente observados, requirieron eventualmente una sonda pleural por el crecimiento subsecuente del neumotórax. Solo uno de los seis manifestó desaturaciones antes de la colocación de la sonda pleural. Los tres casos restantes recibieron sonda pleural por razones ajenas al neumotórax. De los 27 casos con ventilación mecánica con presión positiva dentro de la cohorte de <35 mm, ninguno contribuyó a los 6 casos considerados como fallos en el manejo. El punto de corte de 35 mm tuvo un valor predictivo negativo (VPN) de 95.7% con un área bajo la curva de 0.90.

**Conclusiones:** Todos los neumotórax que miden < 35 mm perpendiculares a la pared torácica sin ninguna alteración fisiológica pueden ser manejados de manera segura con observación clínica independientemente de si necesitan ventilación mecánica o no.

**Palabras claves:** Drenaje, Neumotórax, Toracostomía.

## INTRODUCTION

Chest trauma occurs in 20% of polytrauma patients and is attributed to 20 to 40% of all trauma deaths, second only to head and spinal injuries. Aside from rib fractures and pulmonary contusions, a pneumothorax (PTX) is the most common injury in blunt thoracic trauma.<sup>1</sup> In the trauma bay, tube thoracostomy (TT) is the most commonly performed invasive procedure for chest trauma patients with respiratory distress without a clear cause or in patients with an initial chest X-ray revealing a hemothorax or pneumothorax.<sup>2</sup>

A significant proportion of patients with a PTX are not initially managed with TT. Notably, with the widespread adoption of computed tomography scanners in emergency departments, up to 50% of all PTXs are occult PTXs—missed on initial chest X-ray and revealed on a subsequent chest CT study.<sup>3</sup> These otherwise ‘missed’ PTXs would be managed conservatively by omission unless the patient developed symptoms of respiratory distress encouraging further diagnostic workup. Management of these patients either by observation or with TT has long been dictated by practitioner discretion rather than objective criteria. This study includes and investigates the management of both overt and occult PTXs.

Many physicians elect to routinely perform TT for a traumatic PTX, particularly when patients undergo positive pressure ventilation. Complications following TT are often overlooked and present in more than 10% of

cases, most often related to tube insertion and positioning. Placement of unnecessary TT exposes patients to avoidable morbidity and may prolong hospitalization.<sup>4</sup> An increasing body of literature supports observation in stable patients as an acceptable alternative to TT, with failure of observation rates approaching 6%.<sup>5</sup> Based on previous work,<sup>6</sup> we sought to explore if a PTX measuring ≤ 35 mm in patients who have no physiologic derangement may be safely observed without TT regardless of the need for positive pressure ventilation.

## MATERIALS AND METHODS

This is a retrospective medical record review of trauma patients admitted to a level I trauma center over a 4 years period (January 2009 to February 2013) who were diagnosed with a pneumothorax and underwent chest CT imaging upon admission. All PTXs identified on chest CT were identified and measured. The PTX measurement in centimeters spanned the perpendicular distance of the largest air pocket between the chest wall and the mediastinal or pulmonary structure. Excluded patients were those whom were moribund, were younger than 16 years old, did not undergo chest CT or for whom electronic chest CT image was unavailable, had an ipsilateral hemothorax, received TT before undergoing a chest CT, or for those with an indeterminate reason for TT after initial observational management.

Management of each PTX was categorized according to the initial management, and was described as either observation or immediate tube thoracostomy. The primary outcome was success of observation. Failure was defined as a PTX initially observed which eventually required TT for either enlargement of the PTX or physiological deterioration of the patient. Physiological deterioration was defined as respiratory rate greater than 30 breaths per minute, SpO<sub>2</sub> less than 94% on room air, or heart rate greater than 110 beats per minute and systolic blood pressure less than 90 mm Hg with no other reasonable source of cause.

The study was approved by our institutional review board.

## RESULTS

During the 4 years study period, 2,973 trauma patients were admitted with 416 patients experiencing 461 total pneumothoraces. Two hundred and ninety-six PTXs were excluded for the following reasons: died within 24 hours (19), did not undergo chest CT (160), electronic chest CT unavailable (40), age less than 16 years old (2), ipsilateral hemothorax (9), TT before chest CT (64), and unable to determine reason for TT after initial observational management.<sup>2</sup>

Among the included 143 patients with 165 PTXs, 115 PTXs (70%) were occult, 33 (20%) were overt, and 17 (10%) could not be categorized as occult or overt. The PTXs were almost evenly distributed among left-sided (83) vs right-sided (82). One hundred and forty PTXs were initially observed and 25 received immediate TT. Mean age of all patients was 47 years, 75% males, and had a mean ISS of 29. Mean size of all PTXs were  $14.89 \pm 20.04$  mm.

Categorized by initial management (Flow Chart 1), mean PTX size for TT and observation were  $47.912 \pm 32.50$  and  $8.99 \pm 7.79$  mm, respectively. Sorted by size (Flow Chart 2), 17 (10.3%) PTXs measured  $>35$  mm, whereas 148 (89.7%) measured  $\leq 35$  mm. Out of the 17 that measured  $>35$  mm, 15 (88.2%) received immediate TT. Of the two PTXs  $>35$  mm which were observed, one received a delayed TT for a pleural effusion (six days after PTX diagnosis) and one (5.9%) was safely observed. Of the 148 PTXs in 128 patients which measured  $\leq 35$  mm, 10 (6.8%) PTXs were managed by immediate TT and 138 were observed. Of those 138 PTXs, 129 (93.5%) were safely managed without TT, and nine received TT. Six (4.3%) of those 138 PTXs initially observed were consi-

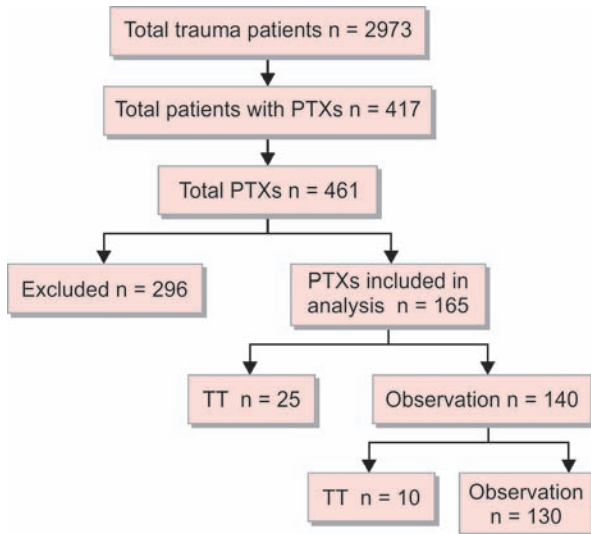
**Table 1:** Demographics and clinical outcomes in observation vs TT patients in 128 patients with PTX  $\leq 35$  mm

N (%)	Demographics		
	Patients with PTX $<35$ mm		
	Observation (n = 119)	TT (n = 9)	p-value
Age (mean)	45.94 $\pm$ 21.5	51.08 $\pm$ 17.5	0.49
Male gender	88 (73.9)	7 (77.8)	1.0
<i>Mechanism of injury</i>			
• MVC	58 (48.7)	0 (0)	—
• Ped struck	7 (5.9)	2 (22.2)	—
• Falls	35 (29.4)	2 (22.2)	—
• Others	19 (16.0)	5 (55.6)	—
ISS (mean)	29.08	29.11	0.99
ICU LOS (days $\pm$ SD)	3.2 $\pm$ 6.3	3.7 $\pm$ 5.7	0.82
HLOS (days $\pm$ SD)	9.8 $\pm$ 8.6	15.1 $\pm$ 19.8	0.12
PPV	21	—	—
Rib fxs	75 (63.0)	7 (77.8)	0.49
Pulmonary comorbidity	12 (10.1)	3 (33.3)	0.07
Mortality	3 (2.5)	1 (11.1)	0.26

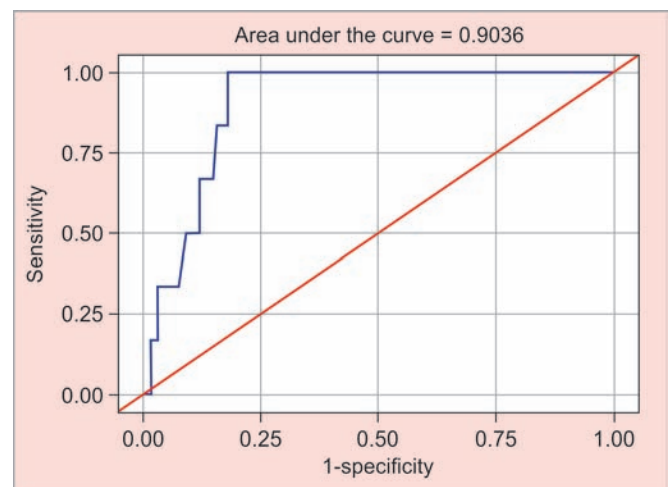
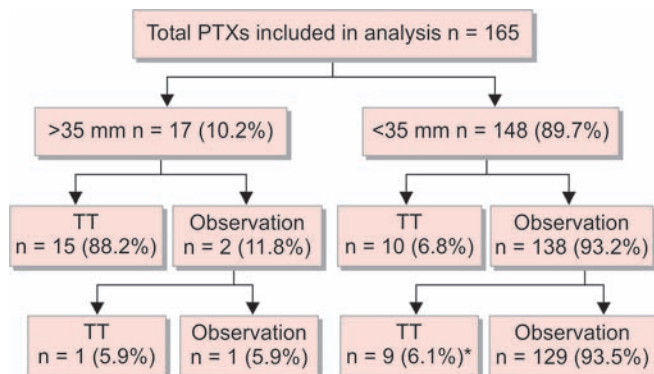
dered failures as they eventually required TT placement specifically for enlargement of the PTX. The remaining three cases received TT for reasons unrelated to the PTX (pleural effusion). Table 1 demonstrates there were no differences in the demographics and clinical outcomes in the observation and TT groups in the  $\leq 35$  mm cohort. A cutoff measurement of 35 mm demonstrated a negative predictive value (NPV) of 95.7% in its ability to predict successful observation of the PTX with an area under the receiver operating characteristic (ROC) curve of 0.90 (Graph 1). The positive predictive value and sensitivity were 100%, while specificity was 98.5%.

The six failed observations included five (83%) males, mean ISS 18, and mean PTX size of  $20.6 \pm 7.1$  mm. Tube thoracostomy was performed for each of these patients due to progression in size of the PTX, while only one of those six had manifested ongoing desaturations prior to TT. Median time until TT removal was 2.5 days.

**Flow Chart 1:** Consort diagram



**Flow Chart 2:** \*Six of the 9 in the  $\leq 35$  mm group who were observed and then received TT were failures. This gives a failure rate of 6/138, or 4.3%



**Graph 1:** Receiver operating characteristic curve to predict successful observation when PTX measures  $\leq 35$  mm



## DISCUSSION

Management of a PTX in blunt chest trauma remains a controversial topic. The question of whether observation of a PTX is safe, especially in the setting of positive pressure ventilation, has remained an unanswered one. Moreover, in the absence of physiologic derangement, no standard protocol currently exists to dictate when to invasively intervene in a stable patient. In summary, we have created a predictive model to determine safe and successful observation of a PTX while avoiding TT. This model demonstrates that when measuring the perpendicular distance of the largest air pocket between the chest wall and the mediastinal or pulmonary structure, a cutoff measurement of 35 mm demonstrates a negative predictive value of 95.7%, with an area under the ROC curve of 0.90.

While some institutions have described their individual schemas to standardize management of PTXs, the relative complexity and low predictability of these models have not resulted in widespread adoption by the critical care community. De Moya et al<sup>6</sup> have previously described a scoring system utilizing air-pocket diameter sizes and anatomical features with a positive predictive value of requiring a chest tube of 78%.

Garramone et al<sup>7</sup> utilized volumetric measurements, requiring longitudinal measurements on axial CT, which we believe to be more difficult and time consuming. Moreover, in their study, CT scans were limited to abdominal scans and therefore, do not necessarily reveal the entire PTX. Our method, on the other hand, is relatively simple, consisting of a single measurement with no calculation required, and utilizes chest CT scans to visualize the entirety of the thorax. Our results and the relative simplicity of our model designate ours as a rapid and clinician-friendly tool.

Observation of a PTX in a patient on positive pressure ventilation has been a highly debated topic in the critical care community. Intuitively, PPV would mandate prophylactic TT to prevent enlargement of a PTX or progression to a tension PTX. Two decades ago, Enderson et al<sup>8</sup> performed the first randomized controlled trial comparing TT (n = 19) and observation (n = 21) in patients with an occult PTX. In the observation arm, eight patients on PPV (38%) required TT due to progression of the PTX, and so the authors advised to perform TT in these patients on PPV. In a multi-institutional, prospective study by the American Association for Surgery of Trauma (AAST) of occult PTXs after blunt trauma, PPV was independently associated with an increased risk of observation failure.

Conversely, subsequent reports and studies have deemed observation safe with acceptable failure rates. In a randomized controlled trial by Brasel et al,<sup>9</sup> e.g.

patients with an occult PTX were randomized to receive tube thoracostomy (n = 18) or undergo observation (n = 21). Eight patients in each arm required PPV, but no differences in progression of PTX was observed.

Our study has a few limitations. First, it is a retrospective study and therefore, subjective patient outcome measures, such as reasons for TT placement after initial observation of the PTX, were based on medical record review *vs* direct physician communication. Additionally, our cohort was in reality a subset sample of patients. We had screened all patients presenting to our institution with a traumatic PTX but excluded many for the reason that the chest CT was not available to be viewed in our electronic medical record system. Lastly, this study lacks long-term follow-up data since patients' medical records were reviewed up to 7 days after initial insult or to patient discharge if the patient was in house for longer than 7 days.

## CONCLUSION

A PTX measuring  $\leq 35$  mm along the perpendicular distance of the largest air pocket between the chest wall and the mediastinal or pulmonary structure in hemodynamically stable patients may be safely observed, even under mechanical ventilation. Our model to measure PTXs on chest CT scans is a simple, clinician-friendly tool to provide objective criteria for the conservative *vs* invasive initial management of PTXs.

## REFERENCES

1. Rhea JT, Novelline RA, Lawrason J, Sachoff R, Oser A. The frequency and significance of thoracic injuries detected on abdominal CT scans of multiple trauma patients. *J Trauma* 1989;29(4):502-505.
2. Menger R, Telford G, Kim P, et al. Complications following thoracic trauma managed with tube thoracostomy. *Injury* 2012 Jan;43(1):46-50.
3. Ball CG, Kirkpatrick AW, et al. Incidence, risk factors, and outcomes for occult pneumothoraces in victims of major trauma. *J Trauma* 2005;59(4):917-925.
4. Maritz D, Wallis L, Hardcastle T. Complication of tube thoracostomy for chest trauma. *S Afr Med J* 2009 Feb;99(2):114-117.
5. Moore FO, Goslar PW, Coimbra R, et al. Blunt traumatic occult pneumothorax: is observation safe?—results of a prospective, AAST multicenter study. *J Trauma* 2011;70(5):1019-1025.
6. De Moya MA, Seaver C, Spaniolas K, et al. Occult pneumothorax in trauma patients: development of an objective scoring system. *J Trauma* 2007 Jul;63(1):13-17.
7. Garramone RR Jr, Jacobs LM, Sahdev P. An objective method to measure and manage occult pneumothorax. *Surg Gynecol Obstet* 1991;173(4):257-261.
8. Enderson BL, Abdalla R, Frame SB, et al. Tube thoracostomy for occult pneumothorax: a prospective randomized study of its use. *J Trauma* 1993;35(5):726-730.
9. Brasel KJ, Stafford RE, Weigelt JA, et al. Treatment of occult pneumothoraces from blunt trauma. *J Trauma* 1999;46(6):987-990.

## **Pneumothoraces on Computed Tomography Scan: Observation using the 35 Millimeter Rule is Safe**

The article by Cropano et al is an interesting work that remarks on the new tendencies in the management of trauma, such as the performance, more commonly every day, of minimally invasive procedures and avoiding nontherapeutic surgical procedures. Evidence indicates that the latter has morbidity and mortality which is not insignificant. Tube thoracostomy (TT) is the most common surgical procedure in chest trauma and has a significant number of complications with a range between 10 and 30% as has been reported in several articles.<sup>1-3</sup> In our experience,<sup>4</sup> we found 9.2% complications in a period of 7 months with 152 trauma cases analyzed prospectively. These were morbid complications as they required either a second TT or open thoracotomy.

The article presented indicates a change of paradigm in chest trauma for insertion of chest tubes, such as 'the 35 mm rule'. This is a cutting point for observation or perform a TT. Analyzing the article, I have several comments. The study refers to chest trauma in general. Table 1 in the article shows that 81% of the cases were secondary to blunt chest trauma. This is important to know as the behavior of penetrating trauma may be different from blunt trauma and if the variables can be applied to all cases. It is important to note that only 4.3% of the observed patients were failures, i.e. physiologic deterioration or increase of pneumothorax that required a chest tube. It would be nice to know if among these failures there was any due to penetrating trauma. Another aspect not defined in detail are the comorbidities: 12 for the observed arm and three for those treated with TT. A significant comorbidity would be chronic obstructive pulmonary disease (COPD): how many of these patients can be observed without performing TT, how many will deteriorate? These patients are high risk for complications due to the poor quality of their pulmonary parenchyma and poor pulmonary reserve.

In summary, this article is a step forward for the reduction of TT in chest trauma. Through clinical assessment and the application of a simple rule, observation of patients can be accomplished safely with a low percentage of failures. To validate the findings of this study, it would be necessary to carry out a prospective and randomized study. Variables, such as trauma mechanisms and comorbidities should be analyzed in detail to avoid deviations in the results.

## **REFERENCES**

1. Menger R, Telford G, Kim P, et al. Complications following thoracic trauma managed with tube thoracostomy. *Injury* 2012;43(1): 46-50.
2. Ball CG, Kirkpatrick AW, et al. Incidence, risk factors, and outcomes for occult pneumothoraces in victims of major trauma. *J Trauma* 2005;59(4):917-925.
3. Deneuille M. Morbidity of percutaneous tube thoracostomy in trauma patients. *Eur J Cardiothorac Surg* 2002;22(5):673-678.
4. Díaz RI, Andrade-Alegre R. Factores de Riesgo para el Desarrollo de Complicaciones en las Toracostomías Cerradas por Trauma. *Panam J Trauma Critical Care Emerg Surg* 2013;2(2):69-73.

**Rafael Andrade-Alegre** FACS, FCCP Professor  
Chief Thoracic Surgery  
Hospital Santo Tomás  
Panamá, República de Panamá  
e-mail: toravasc@cwpanama.net



## INVITED COMMENTARY

**El Rol de la Tomografía Computarizada en el Manejo del Neumotórax: Observación Utilizando El Milimétrico Regla 35 Es Seguro**

El artículo de Copano et al es un trabajo interesante que comenta sobre las nuevas tendencias en el manejo de trauma, tales como el uso diario de los procedimientos mínimamente invasivos y evitar el uso innecesario de procedimientos quirúrgicos. La evidencia indica que este último tiene una importante morbilidad y la mortalidad.

La utilización del Tubo de toracotomía (TT) es el procedimiento quirúrgico más común en trauma de tórax y tiene un número significativo de complicaciones con un rango entre 10 y 30%, como se ha reportado en artículos previos.<sup>1-3</sup> En nuestra experiencia, hemos<sup>4</sup> encontrado 9,2% de complicaciones en un período de 7 meses con 152 casos de trauma analizados prospectivamente. Estas fueron Complicaciones con importante morbilidad ya que requirieron ya sea de un segundo TT o toracotomía abierta.

El presente artículo indica un cambio de paradigma en el traumatismo torácico para la inserción de tubos en el pecho, tales como 'la regla de los 35 mm'. Este es un punto de corte para definir si observamos al paciente o realizamos un TT. Después de analizar el artículo, tengo varios comentarios.

El estudio se refiere a un traumatismo torácico en general. La Tabla 1 of the article muestra que el 81% de los casos fueron secundarios a traumatismo torácico.

Esta distinción es importante ya que el comportamiento de un traumatismo penetrante puede ser diferente de un traumatismo cerrado y las variables se pueden aplicar a todos los casos. Es importante señalar que sólo el 4,3% de los pacientes observados fueron fracasos, es decir, tuvieron deterioro fisiológico o aumento de neumotórax que requirió un tubo torácico.

Sería bueno saber si estos fracasos fueron debido a un traumatismo penetrante. Otro aspecto que no se define con detalle son las comorbilidades: 12 para el grupo observado y tres para los tratados con TT. Una co-morbilidad significativa sería el EPOC: ¿cuántos de estos pacientes pueden ser observadas sin realizar TT, ¿cuántos se deterioran? Estos pacientes tienen alto riesgo de complicaciones debido a la mala calidad de su parénquima pulmonar y su pobre reserva pulmonar.

En resumen, este artículo es un paso adelante en la reducción de los TT en el traumatismo torácico. A través de la evaluación clínica y la aplicación de una regla simple, la observación de los pacientes se puede realizar de forma segura con un bajo porcentaje de fracasos. Para validar los resultados de este estudio, sería necesario llevar a cabo un estudio prospectivo y aleatorizado.

Las variables, tales como mecanismos de trauma y co-morbilidades deben ser analizados en detalle para evitar efectos de confusión.

**REFERENCES**

1. Menger R, Telford G, Kim P, et al. Complications following thoracic trauma managed with tube thoracostomy. *Injury* 2012;43(1): 46-50.
2. Ball CG, Kirkpatrick AW, et al. Incidence, risk factors, and outcomes for occult pneumothoraces in victims of major trauma. *J Trauma* 2005;59(4):917-925.
3. Deneuille M. Morbidity of percutaneous tube thoracostomy in trauma patients. *Eur J Cardiothorac Surg* 2002;22(5):673-678.
4. Díaz RI, Andrade-Alegre R. Factores de Riesgo para el Desarrollo de Complicaciones en las Toracostomías Cerradas por Trauma. *Panam J Trauma Critical Care Emerg Surg* 2013;2(2):69-73.

**Rafael Andrade-Alegre** FACS, FCCP Professor  
Chief Thoracic Surgery  
Hospital Santo Tomás  
Panamá, República de Panamá  
e-mail: toravasc@cwpanama.net