Original Article

How to secure the connection between thoracostomy tube and drainage system?

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BACKGROUND: Thoracostomy tube insertion is one of the common bedside procedures in emergency medicine and many acute specialties. Dislodgement of thoracostomy tube from the connection tube of chest drainage system is an important problem with potential complications such as contamination, infection and pneumothorax. Besides, mere loosening can also lead to malfunction. It is a common practice to tape the connection of the system. This study aimed to evaluate the materials and methods of connection of chest drain system to minimize drainage dislodgement.

METHODS: We conducted an experimental study to assess the tightness of the connection with various taping materials and methods. We selected three commonly used adhesive materials (3M™ Transpore™ Medical tape, 3M™ Micropore™ Medical tape, 3M™ Soft Cloth Tape on Liner) and three different methods (cross method, straight method, nylon band) to secure the junction between the thoracostomy tube and the bi-conical adaptor in the drainage system. The measured outcome was the weight causing visible loosening of the junction between thoracotomy tube and the adaptor.

RESULTS: For each taping material and taping method, 10 trials were performed. The median weight required to disconnect the junction is 26.22 lb for Transpore™, 31.29 lb for Micropore™ and 32.44 lb for Soft Cloth Tape on Liner. A smaller force was required to disconnect if Transpore™ is used ($P<0.001$). There was no statistical significant difference between Micropore™ and Soft Cloth Tape on Liner ($P=0.98$). The median disconnecting force is 32.44 lb for straight taping method, 40.55 lb for cross taping method and 21.15 lb for plastic band. The cross-taping method was the more secure method ($P<0.0001$ when compared with plastic band) ($P=0.033$ when compared with straight method).

CONCLUSION: Cross-taping is the most secure method among the tested varieties in connecting the thoracostomy tube to the chest drainage system. Transpore™ is not a recommended material for thoracostomy tube taping.

KEY WORDS: Thoracostomy tube; Drainage system; Cross-taping

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INTRODUCTION

Thoracostomy tube insertion is one of the common bedside procedures in emergency medicine and many acute specialties. According to the BTS guidelines for chest drain insertion, indications include pneumothorax,

pleural effusion, empyema, traumatic hemopneumothorax and post-operative uses.^[1]

Complications of tube thoracostomy can be classified into mechanical and infective.^[2] Mechanical causes include tube malposition, blockage, dislodgement, re-

expansion pulmonary edema, subcutaneous emphysema, nerve injuries, vascular injuries, esophageal injuries, residual pneumothorax, fistulae, tumor recurrence at insertion site, herniation through the site, chylothorax, and cardiac dysrhythmias. Infective complications include empyema and surgical site infection.

It is a common practice to tape the connection of the system after chest drain insertion and un-taped connection is rarely encountered. Tube dislodgement from the drainage system occurs occasionally, sometimes not identified immediately. It may not be the most common tube-related problem but it is associated with potential complications such as contamination, infection, persistent pneumothorax and misinterpretation of chest drain functioning. Such adverse effects can be minimized by proper taping and connection of the thoracotomy tube.

There are several common adhesive materials and methods in clinical use. However, there is no consensus on which one is better. Moreover, literature search has not identified any past study to assess this issue. This study

evaluates the materials and methods of connection of the chest drain system to minimize drainage dislodgement.

METHODS

We conducted an experimental study to assess the tightness of the connection with various taping materials and methods.

Our study was divided into two parts.

In the first part, we selected three commonly used adhesive materials (3M™ Transpore™ Medical tape, 3M™ Micropore™ Medical tape, 3M™ Soft Cloth Tape on Liner) to secure the junction (a bi-conical-shaped adapter) between the thoracostomy tube and the drainage system (Figure 1). The straight method was used as this method is simple to apply and the application can be more standardized.

In the second part, we used three different methods (straight method, cross method, plastic band) for junction connection (Figures 2 and 3). 3M™ Soft Cloth Tape on

Figure 1. Three commonly used medical tape with adhesive materials. 1: 3M™ Transpore™ Medical tape; 2: 3M™ Micropore™ Medical tape; 3: 3M™ Soft Cloth Tape on Liner.

Figure 2. Three different methods (straight method, cross method, plastic band) for junction connection. Straight method: Two longer tapes (A1 and A2, measured 2.5×9 cm) were applied longitudinally; another two shorter tapes (B1 and B2 measured 2.5×5 cm) were applied making circumferential turns; the connection junction (*) was not covered by the tapes. Cross (X) method: one single long tape measured 2.5×40 cm was used; one complete circumferential turn was made at one end; a diagonal turn was made; a complete circumferential turn was made at the other end; another diagonal turn was made, making an X-shape with step 2; completed with a final circumferential turn; a "window" was created so that the connection junction (*) was visible to detect any disconnection or subtle loosening.

Liner was used in the first two methods for comparison. 3M™ Soft Cloth Tape on Liner was chosen as it was commented to have strong and reliable adhesion in both dry and moist conditions according to the manufacturer information. It has durable backing resistance to tearing and stretching. It also has good adhesion to tubing. These features make it a desirable choice for thoracotomy connection.

In our study, Argyle 28 Fr straight thoracic catheters were used. The bi-conical adaptor was inserted into the catheter to the same depth, i.e. the third marking on the adaptor (measures 1.9 cm from the tip). It assumed similar intrinsic tightness of the connection before any

Figure 3. Two plastic bands (3.6×30 cm, material: nylon 66) were applied at the two ends.

Figure 4. A thoracotomy system. A hook was fixed on the wall. Fishing scale portable scale (Max weight: 110 lbs/Shenzhen West-Boao Science & Technology Co., Ltd). A nylon ring was applied through the end side hole of a 28 Fr straight Argyle chest catheter. A drainage tube was connected to the other end. Various strength of longitudinal force was generated by applying different weight to the weight reader (à). The measured outcome was the weight causing visible loosening of the junction (#) between the thoracotomy tube and the chest drainage system adapter.

taping material was applied. Thoracic catheters and connectors were reused while taping materials were newly prepared by ungloved hands.

A thoracotomy system was connected according to Figure 4. The measured outcome was the weight causing visible loosening of the junction between the thoracotomy tube and the chest drainage system adapter. It was measured by a weight reader which showed readings of 2 decimal places. The procedure was video-taped and then replayed. The maximal readings obtained until visible disconnection was taken as the disconnecting force.

Statistical analysis

The weight unit pound (lb) was used and taken to 2 decimal figures. The median values were rounded off to 2 decimal figures. The data were input in an Excel sheet and analyzed using a statistical package for social science (IBM SPSS version 20 for Windows).

The Kruskal-Wallis test was employed for comparison between multiple groups. Pairwise multiple comparisons were carried out with Bonferroni's correction. Level of significance was taken at 5% and *P* value of less than 0.05 was regarded as statistically significant.

RESULTS

For each taping material and taping method, ten trials were performed.

For part 1, the median weight required to disconnect the junction was 26.22 lb for Transpore™, 31.29 lb for Micropore™ and 32.44 lb for Soft Cloth Tape on Liner (Table 1).

A smaller force was required to disconnect if Transpore™ was used when compared with Micropore™ and Soft Cloth Tape on Liner ($P<0.0001$). There was no statistical significant difference between Micropore™ and Soft Cloth Tape on Liner ($P=0.98$) (Table 2).

Table 1. Median weight required to disconnect the junction in three different taping materials

Tapes	Median (lb)	Inter-quartile range (IQR)
3M™ Transpore™	26.22	1.94
3M™ Micropore™	31.29	2.17
3M™ Soft Cloth Tape on Liner	32.44	1.07

Table 2. *P*-value of comparing three different taping materials

Comparison	<i>P</i> -value
3M™ Transpore™ 3M™ Micropore™	<0.0001
3M™ Transpore™ 3M™ Soft Cloth Tape on Liner	<0.0001
3M™ Micropore™ 3M™ Soft Cloth Tape on Liner	0.980

Table 3. Median weight required to disconnect the junction in three different connection methods

Connection method	Median (lb)	Inter-quartile range (IQR)
Straight	32.44	2.41
Cross	40.55	3.30
Plastic band	21.15	2.39

Table 4. *P*-value of comparing three different connection methods

Comparison	<i>P</i> -value
Straight Cross	0.033
Straight Plastic band	0.033
Cross Plastic band	<0.0001

For part 2, the median disconnecting force was 32.44 lb for straight taping method, 40.55 lb for cross taping method and 21.15 lb for nylon band (Table 3).

Cross-taping was the more secure method compared with the other two methods ($P<0.0001$ as compared with plastic band and $P=0.033$ as compared with straight method) (Table 4).

DISCUSSION

This study applied an objective assessment, instead of subjective feeling, for the strength of the various common methods of connection of the thoracostomy tube to the drainage system.

Micropore™ is a latex-free, hypoallergenic paper tape with good adhesive power. Its advantage is gentle to skin. The suggested applications include small to medium dressing, damp skin, securing lightweight tubing, ostomy appliances, fragile skin and repeated taping.

Transpore™ is another choice of latex-free and hypoallergenic tape material. It is easy to tear into very thin strips to tailor the tape for various dressings and devices. It is easy to use with gloves. The suggested applications are securing tubing and devices (e.g., catheters, IV tubing), bulky dressing and when tape width must be customized. One clinical use in our department is anchoring of an endotracheal tube on intubated patients. These features appeared to be advantageous to be used in our study. However, its connection strength was the least among the three from our study results.

Soft Cloth Tape on Liner is also hypoallergenic and latex-free. It provides strong adhesion to both skin and tubing. It has durable resistance against tearing and stretching. The "Liner" refers to the underlying removable paper with dimensions reference so that

the width and length can be customized easily. It also adheres well in both moist and dry conditions. The suggested applications are securing tubing.

The cross method is recommended for two main reasons. The first reason is that it provides a strong connection. The second reason is that it creates a "window" making the connection easily visualized during nursing care. Part of the bi-conical adaptor was not covered by the tapes to ensure proper fitting to the thoracostomy tube and drainage system. It can prevent non-visualization of the subtle loosening or disconnection.

The use of commercial nylon band is neat and simple but it may not be readily available in the clinical setting. Also, their strength is not strong enough.

There are some limitations in our study. First, the insertion depth between the bi-conical adaptor and thoracotomy catheter may not be identical, although same size and type of the catheters are used. And the depth is standardized by the same marking on the adaptor, but differences are still possible.

Second, the recommended cross method takes more technical steps than the straight method. It involves the cutting of adhesive tape into long strip and making circumferential turns. The tightness of applications may not be the same. However, most trained clinical staff could readily master the skills with some practice. Hence, the application can easily be generalized to the clinical settings.

Next, different sizes of thoracotomy tube are used in different clinical situations while 28 Fr straight Argyle chest catheters are used in our study. For instance, a larger bore is used in traumatic hemopneumothorax when a smaller one in spontaneous pneumothorax. While a small bore is used, it is difficult to apply tapes by the cross method, as well as the recommended size of taping materials as stated in our study may not be applicable.

In conclusion, application of 3M Micropore™ and Soft Cloth on Liner is more secure in connecting the thoracostomy tube to the chest drainage system. However, it is inconclusive on which one is more superior to another.

Cross-taping is the most secure method among the tested varieties in thoracotomy connection. It would be worthwhile to conduct another study on comparison between 3M Micropore™ and Soft Cloth on Liner. A standardized use of taping material and method can prevent thoracotomy related complications and provide better care to our patients.

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