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Evaluation of a Tunneling Technique under the Latissimus Dorsi Muscle for Thoracostomy Tube Placement in Eleven Dogs

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Abstract : The present study evaluated the outcome of use of thoracostomy tube tunneling technique under the latissimus dorsi muscle for the evacuation of postoperative pneumothorax induced by thoracotomy in 11 dogs. A stab incision was made through the skin and the latissimus dorsi muscle over the rib in the fifth intercostal space caudal to a surgical window. The thoracostomy tube with a Kelly hemostat was advanced into the thoracic cavity in a cranioventral direction through the sublatissimal tunnel. After tube placement, a # 1 nylon horizontal mattress suture was placed around the skin incision. The thoracostomy tube was removed after creating a negative pressure in the thoracic cavity. Dogs were monitored after surgery for pneumothorax, subcutaneous emphysema, clinical signs including dyspnea, and tube kinking in a muscle tunnel using physical examination and postoperative radiography. There was no tube kinking in the sublatissimal tunnel in 11 dogs on introducing the tubes into the thoracic cavity. The mean (± SD) follow-up period was 19 ± 10 months. On postoperative radiography, there was no evidence of pneumothorax in 11 dogs. Subcutaneous emphysema was identified around the stab incision in a dog postoperatively. The subcutaneous emphysema disappeared spontaneously within 3 days. On postoperative physical examination, there was no evidence of dyspnea in 11 dogs. Our results suggest that the sublatissimal tunneling technique for thoracostomy tube placement is effective to prevent air leakage around the thoracostomy tube while the tube remains in the thoracic cavity and along the thoracostomy tunnel after tube removal. Tunneling under the latissimus dorsi muscle should be considered the thoracostomy tube placement technique to prevent iatrogenic pneumothorax with first priority.

Key words **:** sublatissimal tunnel, thoracostomy tube, pneumothorax, dog.

Introduction

Thoracostomy tube placement is indicated for the management of significant accumulation of pleural effusion that necessitates repeated pleural drainage, for the treatment of pneumothorax if air continues to accumulate despite evacuation of the thoracic cavity by needle thoracocentesis, and for the evacuation of postoperative pneumothorax induced by thoracotomy (9,10,12,20). Tube-associated pneumothorax can be a fatal complication of thoracostomy tube use (11,14). Pneumothorax may occur after tube placement, while the tube remained in the thoracic cavity as a result of tube mutilation by the patient, loosening of tube connections and adapters, or inadvertent extraction of the tube, and after tube removal (5,14). Avoidance of iatrogenic pneumothorax during tube placement and removal is essential goal for successful usage of thoracostomy tubes (8,18). A latissimus dorsi tunneling technique is used by some to provide an additional layer of seal for preventing air leakage into the thoracic cavity when tubes placed and removed (16). To the authors' knowledge, there are no published data evaluating a tunneling technique under the latissimus dorsi muscle for thoracostomy tube placement in dogs.

The purpose of our study was to evaluate the outcome of use of thoracostomy tube tunneling technique under the latissimus dorsi muscle for the evacuation of postoperative pneumothorax induced by thoracotomy in dogs.

Materials and Methods

Criteria for selection of cases

Medical records of all dogs that were admitted to the Veterinary Medical Teaching Hospital of Konkuk University and Woosung Animal Hospital between September 2009 and June 2012 and underwent a thoracostomy tube tunneling technique under the latissimus dorsi muscle for the evacuation of postoperative pneumothorax induced by thoracotomy were reviewed. Dogs that underwent thoracotomy because of bite wounds or hit-by-car were excluded so that no dogs with thoracic injury were included in the study.

Thoracostomy tube

A commercially available polyvinyl chloride thoracostomy

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tube (PVC Thoracic Catheter, Sewoon Medical Co., LTD, Korea) was used. The same surgeon (HY) placed all thoracostomy tubes.

Thoracostomy tube tunneling technique under the latissimus dorsi muscle

A stab incision in the dorsal third of the left lateral thoracic wall was made through the skin and the latissimus dorsi muscle over the rib in the fifth intercostal space caudal to a surgical window using a #11 scalpel blade (Fig 1). A curved Kelly hemostat was used to create a tunnel as wide as the width of the curved Kelly hemostat under the latissimus dorsi muscle from the site of a stab incision to the third intercostal space cranially in the middle third of the thoracic wall, and the Kelly hemostat was removed. The tip of a thoracostomy tube was grasped in the tip of a Kelly hemostat with the tube parallel to the body of the Kelly hemostat. The thoracostomy tube with a Kelly hemostat was then passed through the tunnel created under latissimus dorsi muscle from the site of a stab incision to the third intercostal space cranially. Once the tip reached the intercostal space three intercostal spaces cranial to a stab incision, the Kelly hemostat was raised perpendicular to the thoracic wall. The thoracostomy tube with Kelly hemostat was then firmly grasped 1 to 2 cm from the body wall with one hand while the other hand was used to pop the thoracostomy tube with Kelly hemostat through the thoracic wall musculature into the pleural space. Once the thoracostomy tube entered the pleural space, the Kelly hemostat was removed and the tube was advanced in a cranioventral direction without resistance until the predetermined length of the tube to be inserted from the skin incision to the thoracic inlet was inserted.

After tube placement, a # 1 nylon (Blue Nylon, Ailee Co., LTD, Korea) horizontal mattress suture (to be used later as a Rumel tourniquet during thoracic evacuation) was placed around the skin incision, and the tube was sutured to the skin and underlying fascia with four friction sutures using # 1 nylon (17). The thoracostomy tube was removed after creating a negative pressure in the thoracic cavity.

Fig 1. The cutting surface of the skin, subcutaneous, and the latissimus dorsi muscle. A stab incision in the dorsal third of the left lateral thoracic wall is made through the skin and the latissimus dorsi muscle over the rib five intercostal spaces caudal to a surgical window using a #11 scalpel blade.

Pain management

Selective intercostal nerve block and intrapleural regional analgesia were employed together to alleviate pain associated with thoracotomy or thoracostomy tube placement.

Evaluation of a tunneling technique under the latissimus dorsi muscle

Manipulation of a thoracostomy tube was described in relation to ease of tube placement and the possibility of complications, such as pneumothorax, subcutaneous emphysema, and tube kinking. Dogs were monitored after surgery for pneumothorax, subcutaneous emphysema, clinical signs including dyspnea, and tube kinking in a muscle tunnel using physical examination and postoperative radiography.

Results

Five male and 6 female dogs underwent thoracostomy tube tunneling technique under the latissimus dorsi muscle for reasons related to pulmonary neoplasia (n = 5), pulmonary abscess (n = 2), patent ductus arteriosus (n = 2), lung lobe torsion (n = 1), and cardiac neoplasia (n = 1). Breeds were Shih Tzu (n = 3), Maltese (n = 2), Yorkshire Terrier (n = 2), Pug (n = 2), English Cocker Spaniel (n = 1), and Bichon Frise (n = 1). Mean (± SD) body weight for dogs was 5.2 ± 2.1 kg (range 3.1 to 8.5 kg). The age range of dogs was 1 to 12 years, with mean (± SD) of 8.4 ± 3.9 years. A thoracostomy tube with a 4.0 or 4.9 mm outer diameter was used in dogs (n = 7) less than 5 kg or dogs (n = 4) greater than 5 kg respectively.

Manipulation of thoracostomy tube

Tubing attached to a hemostatic forceps was not difficult to manipulate for introduction of the tube through the sublatissimal tunnel in the chest. There was no resistance on introducing the thoracostomy tube with a hemostatic forceps through the sublatissimal tunnel. Additional manipulation including traction, rotation, and advancement of the thoracostomy tube was not required. There was no tube kinking in the sublatissimal tunnel in 11 dogs on introducing the tubes into the thoracic cavity.

Postoperative evaluation

The mean (± SD) follow-up period to evaluate pneumothorax, subcutaneous emphysema, and dyspnea after tube removal was 19 ± 10 months (range 6 to 33 months). On postoperative radiography, there was no evidence of pneumothorax in 11 dogs. On postoperative physical examination, subcutaneous emphysema was identified around the stab incision for introduction of thoracostomy tube in a dog postoperatively. The

subcutaneous emphysema disappeared spontaneously within 3 days. There was no evidence of dyspnea in 11 dogs.

Discussion

Our results suggest that the sublatissimal tunneling technique for thoracostomy tube placement is effective to prevent air leakage around the thoracostomy tube while the tube remains in the thoracic cavity and along the thoracostomy tunnel after tube removal. Tunneling under the latissimus dorsi muscle should be considered the thoracostomy tube placement technique to prevent iatrogenic pneumothorax with first priority.

In human beings, pneumothorax after thoracostomy tube removal has accounted for 27% of reported complications, and diagonal subcutaneous tunneling has been recommended to decrease the chance of air entry into the pleural space on tube removal (3,13). In veterinary medicine, conventional methods for thoracostomy tube placement include trocar or hemostat-assisted thoracostomy tube placement with a subcutaneous tunnel (1,2,4,7,15). In this technique, after skin incision, a large curved forceps or trocar is used to create a tunnel through the subcutaneous tissues. In our study, thoracostomy tube was guided through tunnel under the latissimus dorsi muscle. The technique of tunneling under the latissimus dorsi muscle provides multiple layers (skin, subcutaneous tissue, and muscle) of seal, whereas the technique of tunneling subcutaneously has one layer (skin) of seal. The multiple layers providing seal likely contributed to prevent air leakage around the thoracostomy tube while the tube remained in the thoracic cavity and along the thoracostomy tunnel after tube removal. It is possible that multiple layers provide enough airtight seal when a large tunnel is made by using a Carmalt or horizontal mattress suture (used as a Rumel tourniquet during thoracic evacuation) is placed inadvertently around the skin incision, and would be a plausible explanation for the one subcutaneous emphysema documented here that was identified around the stab incision for introduction of thoracostomy tube postoperatively and disappeared spontaneously within 3 days without development of pneumothorax.

Conventional equipments for guiding thoracostomy tube include a trocar and hemostat (1,5,19). A trocar and hemostat both have advantages and disadvantages. Hemostat-assisted technique uses less expensive tubing which may be more readily available to most practicing veterinarians, but causes more chest wall trauma during placement than does the trocar method (5,11,14,18). In our study, large tunnel or chest wall trauma could be created during hemostat-assisted tube placement; however, the multiple layers including skin, subcutaneous tissue, and muscle provided enough airtight seal.

Tubing attached to hemostatic forceps has been described to be difficult to manipulate for introduction of the tube into the chest (21). A hemostat with a tube has a dull tip and irregular shape with the tube protruding out of the hemostat, necessitating more forceful introduction, which might cause tube kinking in the thoracosotmy tunnel. In our study, there was no evidence of tube kinking in the sublatissimal tunnel in all dogs on introducing the tubes into the thoracic cavity. A curved Kelly hemostat was used to create a tunnel as wide as the width of the curved Kelly hemostat under the latissimus dorsi muscle from the site of a stab incision to three intercostal spaces cranially, and the Kelly hemostat was removed. The tunnel created by a Kelly hemostat in advance might help introduce the tube into the thoracic cavity without resistance.

In veterinary medicine, the skin incision for thoracostomy tube placement is closed with stitches or staples and bandaged, which can prevent infection and provide additional layer of airtight seal. However, it is possible that air leakage may occur along the thoracostomy tunnel after tube removal and before stitches and bandage application. The biggest advantage in using the technique of tunneling under the latissimus dorsi muscle is that enough airtight seal occurs simultaneously with tube removal.

Selective intercostal nerve block and intrapleural regional analgesia are employed singly or together to alleviate pain associated with thoracotomy or thoracostomy tube placement (6). Selective intercostal nerve block can be used to perform thoracotomy or thoracostomy tube placement preoperatively. Intrapleural regional analgesia is achieved through a thoracostomy tube postoperatively or direct administration into thoracic cavity intraoperatively. In our study, pain could be caused by not only intercostal muscle incision for thoracotomy but also latissimus dorsi muscle incision for thoracostomy tube placement. Selective intercostal nerve block and intrapleural regional analgesia were employed together to alleviate pain associated with thoracotomy and muscle incision for thoracostomy tube placement.

The significant anatomical consideration for the technique of tunneling under the latissimus dorsi muscle is that one must make sure that the stab incision penetrates the latissimus dorsi muscle. Penetration of the latissimus dorsi muscle can be verified by visualizing the cut edge of muscle. Thick subcutaneous fat may obscure this observation, but gentle retraction of the fat with the edge of the scalpel or by grasping the cut edge of the latissimus dorsi with a thumb forceps can facilitate verification.

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흉강 튜브 삽입을 위한 넓은 등근 아래 터널 만들기 방법에 대한 평가

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요 약 : 본 연구는 개흉술을 실시한 11 마리 개에서 수술 후 흉강 내 음압 형성을 위한 흉강 튜브 삽입방법으로 넓은 등근 아래 흉강 튜브 삽입 방법의 효과를 평가하기 위해 실시 하였다. 흉강 튜브 삽입을 위해 수술 창 뒤쪽으로 다섯 번째 늑간 늑골 위 피부와 넓은 등근에 작은 절개창을 형성하였다. 지혈겸자를 장착한 흉강 튜브를 근육 아래 터널을 통과하여 흉강 내로 삽입하였으며 튜브 장착 후 절개창 주위에 매트리스 봉합법을 이용하여 봉합사를 설치하였다. 수술 후 흉강 내 음압을 형성한 다음 흉강 튜브를 제거하였다. 튜브 관련 부작용을 확인 하기 위해 튜브 삽입 시 튜브 꺽임 현상과 수술 후 신체 검사 및 방사선 검사를 통한 기흉, 피하 기종, 호흡곤란 여부를 확인 하였다. 튜브 삽입 시 튜브 꺽임 현상과 수술 후 기흉 및 호흡 곤란 증상이 11 마리 개 모두에서 확인 되지 않았다. 신체 검사에서 튜브 삽입 주위 피하 기종이 한 마리에서 관찰 되었으나 별다른 치료 없이 3일 후에 사라졌음을 확인 할 수 있었다. 음압 형성 후 평균 (± SD) 추적 기간은 19 ± 10 개월 이었다. 결론적으로 넓은 등근 아래 흉강 튜브 삽입 방법은 튜브가 흉강 내 유지 될 때와 튜브 제거 후 남게 되는 터널을 통한 흉강 내 공기 유입 차단에 효과적이며 흉강 튜브 장착 시 우선적으로 고려 되야 할 방법으로 사료 된다.

주요어 : 넓은 등근 아래 삽입 방법, 흉강 튜브, 기흉, 개