

Interlobar fixation using TachoSil®: a novel technique

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Background: We evaluated the use of TachoSil® for anchoring middle lobe to lower lobe after upper right lobectomy.

Methods: The fixation of middle lobe to lower lobe was required in 39/213 consecutive upper lobectomies. In 19/39 (49%) cases, it was performed with suturing and/or stapler (standard group) and in 20 cases (TachoSil group) with Tachosil® alone.

Results: The operative time, complications, length of chest drain and hospital stay were similar between two groups. However, standard compared to TachoSil® group presented a higher incidence of atelectasis (5% vs. 0%, P=0.4) and air leaks (5% vs. 0%, P=0.4) but it did not reach significant difference. Our technique was safe, easy, and quick.

Conclusions: Upon contact with pleura, the clotting factors of TachoSil® dissolved and formed a fibrin network which glued the collagen sponge to the pleura surface. It allowed to fix the middle lobe to lower lobe without restricting lung re-expansion and/or injuring the parenchyma.

Keywords: Torsion; middle lobe; fixation; TachoSil®; lobectomy

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Introduction

Lobar torsion, despite rare, is a potential fatal complication after pulmonary resection. Right middle lobe torsion after upper lobectomy is commonest, but any lobe can be affected. Thus, middle lobe fixation to the lower lobe is widely recommended, if the middle lobe is very mobile due to complete oblique fissure and lack of pleural adhesion.

The aim of the present study is to evaluate the feasibility and the safe of a new technique of middle lobe fixation after upper right lobectomy using TachoSil® (haemostatic surgical patch; Nycomed, Linz, Austria).

Materials and methods

From January 2006 to June 2014, upper lobectomy via thoracotomy was performed in 213 consecutive cases for

treatment of non-small cell lung cancer (NSCLC). The fixation of middle lobe was required in 39/213 (18%) consecutive cases because after standard resection of upper lobe and during re-ventilation, the middle lobe was mobile enough to twist with a degree of rotation in from 90 to 360 degrees due to the lack of bridge between contiguous lobes.

In 19 consecutive patients operated from January 2006 to December 2009, the middle lobe was fixed to lower lobe using suture and/or stapler (standard group) while from January 2010 in 20 consecutive cases (TachoSil group) the new procedure using TachoSil® was attended.

The inter-group differences were retrospectively compared to evaluate the feasibility of TachoSil procedure. Being an unproven technique, it was approved by the Institutional Review Board of Second University of Naples; all patients were informed about the pros and cons of the procedure and a signed consent form was obtained.

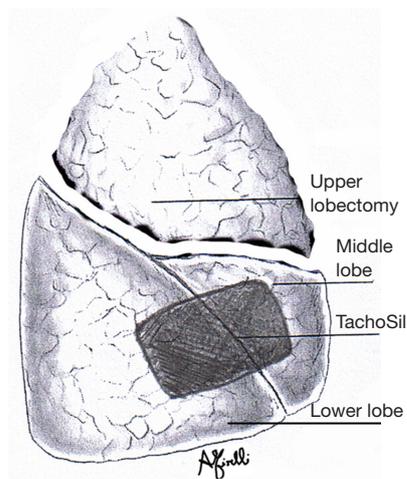


Figure 1 TachoSil® is placed on the pleura of the middle lobe and lower lobe in a bridging manner towards the oblique fissure.

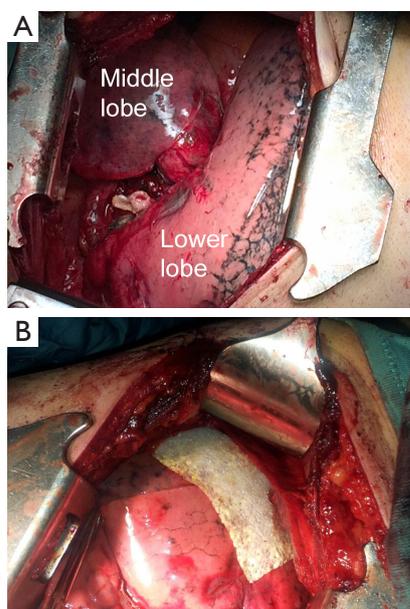


Figure 2 At the end of upper lobectomy during re-ventilation, the middle lobe was very mobile due to complete oblique fissure (A). TachoSil allowed a strong adhesion between the two inflated lobes (B).

Statistical analysis

Data are expressed as means with standard deviation. The inter-group differences were assessed using Chi-square test and/or Mann-Whitney tests as appropriate. A $P < 0.05$ was considered statistical significant. MedCalc statistical software (Version 12.3, Broekstraat 52; 9030 Mariakerke;

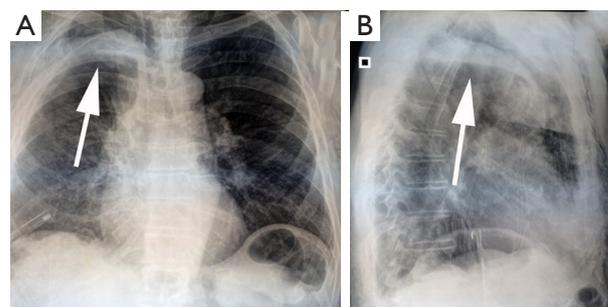


Figure 3 Postero-anterior (A) and lateral view (B) of postoperative chest radiograph showed the fully expanded right lung with normal vascular markings. TachoSil® (arrow) was well evident in both views.

Belgium) was used for analysis.

Technique

The procedure is summarized in *Figure 1*. When the middle lobe is completely separated from the lower lobe, at the end of the upper lobectomy and after completing all the essential steps of resection such as radical lymphadenectomy, testing of the bronchus, proper haemostasis, control of air leaks, and washing the pleural cavity, the anesthetist is asked to inflate the lung. If a natural shift of middle lobe is noticed during re-ventilation as above reported (*Figure 2A*), our technique of fixation is indicated.

A standard sponge of TachoSil® (9.5 cm × 4.8 cm) is prepared. The lung ventilation is slightly decreased to obtain incomplete inflated lobes. The yellow surface of the TachoSil® is placed on the pleura of the middle and lower lobes in a bridging manner towards the oblique fissure (*Figure 2B*). The sponge is gently compressed over the target area for at least 3 min until coagulation is triggered. The soluble fibrinogen is transformed by thrombin into fibrin, which polymerizes into a fibrin clot. The deposition of the clot causes the conglutination of the collagen patch to the pleura allowing the secure adhesion of two contiguous lobes. Then, the lung is completely inflated to check final position of the fixation before inserting chest drain and closing thoracotomy. Postoperative radiograph showed the fully expanded right lung with normal vascular markings (*Figure 3*).

Results

The results are shown in *Table 1*. The two groups were

Table 1 Characteristics of study population

Variables	All patients, n [%]	Standard group, n [%]	TachoSil group, n [%]	P value
Number	39 [100]	19 [49]	20 [51]	
Female	15 [38]	7 [37]	8 [40]	1.0
Age (years)	66.9±3.7	66±2.9	67±8.9	0.9
Smokers	36 [92]	17 [89]	19 [95]	0.9
Pre-operative co-morbidity				
Pulmonary disease	13 [33]	5 [26]	8 [40]	0.9
Coronary artery disease	5 [13]	3 [16]	2 [10]	0.9
Hypertension	7 [18]	4 [21]	3 [15]	0.9
Prior stroke	1 [3]	1 [5]	0	0.9
Diabetes mellitus	5 [13]	2 [10]	3 [15]	0.9
Hepatic disease	3 [8]	1 [5]	2 [10]	0.9
ppoFEV1 (%)	76.3±4.6	76±8.5	77±2.9	0.7
ppoDLCO (%)	72.6±8.1	72±4.3	73±2.9	0.5
Pathological stage				
Ia	10 [26]	6 [32]	4 [20]	0.6
Ib	10 [26]	4 [21]	6 [30]	0.6
IIa	9 [23]	4 [21]	5 [25]	0.9
IIb	7 [18]	3 [16]	4 [20]	0.9
IIIa	3 [8]	2 [10]	1 [5]	0.4
Operative time (minutes)	114±56	115±39	113±24	0.7
Time for the fixation (minutes)	2.9±2.1	3.2±2.3	2.5±1.7	0.6
Histology				
Squamous cell cancer	14 [36]	7 [37]	7 [35]	0.8
Adenocarcinoma	19 [49]	10 [53]	9 [45]	0.6
Others	6 [15]	2 [10]	4 [20]	0.7
Post-operative course				
Chest drain (days)	3.7±1.0	3.7±3.6	3.6±2.7	0.5
Hospital stay (days)	5.2±3.4	5.4±3.4	5.1±5.9	0.6
Residual cavity at X-ray (yes)	1 [2]	1 [5]	0	0.9
Complications				
Arrhythmia	1 [2]	1 [5]	0	0.9
Atelectasis	2 [5]	2 [10]	0	0.4
Air-leaks	2 [5]	2 [10]	0	0.4

ppoFEV1, predicted postoperative forced expiratory volumes in one second; ppoDLCO, predicted postoperative diffusing capacity of lung.

well matched regarding age, pre-operative co-morbidity, respiratory value, pathological stage. No intraoperative complications and death were registered.

The operative time, length of chest drain and hospital stay were similar between two groups. Standard group presented a higher incidence of atelectasis and air leaks than

TachoSil® group but it did not reach significant difference.

Discussion

Torsion of the remaining lobe(s) after lobectomy is a rare but a potential fatal event due to hemorrhagic infarction of

Table 2 Comparison of different strategies for interlobar fixation

Strategy	Time	Benefit	Potential risk	Allergy	Cost of the procedure
Suturing or stapling (1)	Long	Assurance	Air-leaks; haemorrhage; strong adhesions	None	Low
Bioglue (2,5)	Short	Doubt	Low adhesion	None	Medium
Collagen fleece with suturing (7)	Short	Assurance	Air-leaks; haemorrhage	None	Medium
Absorptive sheet and fibrin glue (9)	Short	Assurance	Very low	None	High
Present method	Short	Assurance	Very low	None	Medium

affected lobe and fatal gangrene (1,2). It can occur in any lobe with increased mobility associated with a complete fissure in the absence of pleural adhesions and/or in presence of risk factors including atelectasis or insufficient inflation of lobe, an extended flap, pneumothorax and/or effusions, and transposition of the pulmonary ligament (3). Fixation of middle lobe to lower lobe using suture and/or stapler is traumatic and may produce air leaks, and hemorrhage due to laceration of pulmonary parenchyma. In addition, the strong adhesions between the two lobes may cause some technical difficulty in re-thoracotomy.

Alternative procedures have been proposed but none methods have been found as suitable for all patients.

Kutlu *et al.* (4) prevented middle lobe torsion using a pleural flap. However, this technique is not easy to reproduce, adds one more surgical step, has a small risk of bleeding and is technically unfeasible if pleurectomy is associated to lung resection.

Purohit *et al.* (5) applied BioGlue® (CryoLife Europa Ltd, Hampshire, United Kingdom) to the surfaces of middle and lower lobe for having adhesion while Le Pimpec-Barthes *et al.* (6) obtained similar results using a resorbable anti-adhesive membrane usually indicated in preventing post-operative pleural adhesions. Despite the good results, the power of tissue adhesion of both substances may be poor on damp tissue.

Higashiyama *et al.* (7) sutured Tacho-comb® (Nycomed Pharmaceutical Co., Ltd., Denmark) to the pleura of middle and lower lobes. Despite no complications were seen, such technique may be traumatic especially in emphysematous lung.

Venuta *et al.* (2) used Coseal® (Baxter International Inc., Deerfield, Ill) to fix the middle and lower lobe on inflated lungs to avoid unintentional restriction of lung expansion. However, such procedure may have some limitations with a thoracoscopic approach. That should not be underestimated considering that lobar torsion may complicate thoracoscopic

lobectomy (8).

Uramoto *et al.* (9) used for interlobar fixation absorptive sheet and fibrin glue. The absorptive sheet soaked in fibrinogen was placed over the contiguous lobes in a bridging manner. Next, liquid thrombin was placed dropwise onto the sheet, followed by fibrinogen and thrombin, which were sprayed together to adhere to each other more tightly. This fixation was performed in three locations for a few minutes. Being atraumatic, this procedure prevents any parenchymal damage. However, it is slightly expensive and that could limit its large use.

TachoSil® is a fixed combination of a collagen matrix coated with the coagulation factors, human fibrinogen and human thrombin. In thoracic surgery, it is widely used to control bleeding and air leaks after lung resection but its use for interlobar fixation has not been reported before the present paper. Our results showed that our technique is feasible and safe. In comparison to control group, no significant difference in terms of operative time, chest drain duration and length of hospital stay were found with use of TachoSil. In all cases the fixation of middle lobe to lower lobe was obtained without any particular complications during the operation and in the postoperative course.

Upon contact with pleura, the clotting factors of TachoSil® dissolve and form a fibrin network which glues the collagen sponge to the pleura surface. It allowed to fix the middle lobe to lower lobe without restricting lung re-expansion and/or injuring the parenchyma. Compared to other procedures, our method has several advantages as summarized in *Table 2*. (I) The honeycomb-like collagen structure of TachoSil® remains flexible and extensible, thus it does not prevent the expansion capability of the remaining lobes to obliterate the chest cavity. (II) TachoSil® adheres strongly with lung parenchyma and it does need of additional sutures or fibrin glue, as previous reported (7,9), for anchoring the two remaining lobes. That avoids the lung injuries and reduces the cost of the procedure. (III) The

complete inflated lung is not required for its application thus theoretically it may be used also during thoracoscopic procedure.

Finally, the fixation of middle lobe using TachoSil is easy and available procedure. However, our results should be confirmed by larger prospective studies.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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