Postoperative Hemorrhage after Pulmonary Resection*

II. Postoperative hemorrhage following pulmonary resection as an indication for secondary thoracotomy

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HEMORRHAGE FOLLOWING PULMONARY resection is a difficult postoperative complication to treat. Usually, rethoracotomy must be performed. However, few publications in the world literature deal with the indications or therapeutic results of this procedure. Secondary thoracotomy, being performed in the course of so-called postoperative diseases and contributing to stress, is a serious problem. Rethoracotomy is not a method of choice, but a necessity. In our Clinic, rethoracotomy is a routine procedure in cases of hemorrhage after pulmonary resection because it provides more favorable conditions for mastering the hemorrhage and saving the patient's life and is attended by fewer complications than conservative treatment.

The causes of hemorrhage and necessity of secondary thoracotomy have been analyzed in another communication.

INDICATIONS

Until 1960, indications for secondary thoracotomy were considered on an individual basis, as a rule. However, with growing experience, although the individual approach continues, the indications for secondary thoracotomy have become better defined.

At present, the indications for secondary thoracotomy and the choice of the proper moment for the intervention are based on a graphic registration of the rhythm of blood loss. Certain typical or frequently occurring types of bleeding rhythm have been observed (Fig. 1), in the presence of which, even if blood stagnation in the thorax has not been demonstrated, indications are considered existing for immediate secondary thoracotomy.

1. Blood loss of 400 to 600 ml./hr. for two to three hours after resection to a total of at least 1200 ml.
2. Blood loss of about 200 ml./hr. up to eight hours after resection, total 1500 to 1600 ml. showing no signs of subsiding.
3. Blood loss of about 100 ml./hr. for 20 to 24 hours after operation, total 200 to 2200 ml. without tendency to diminish.
4. Cases of hemorrhage in which, in spite of diminishing rhythm of, blood loss stagnation of 700 to 1000 ml. of blood in the thorax or presence of a hematoma compressing the mediastinum is observed radiologically.

Nearly one-half of the secondary thoracotomies in our material were performed within eight hours after the pulmonary resection, i.e. in accordance with indications 1 and 2.

OPERATIVE TECHNIQUE

The typical procedure when doing secondary thoracotomy in our Clinic consists in opening the thorax as quickly as possible, while the patient lies on his side. The hema-

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**Table 1—Extent of Resection and Secondary Thoracotomy**

<table>
<thead>
<tr>
<th>Resection and Secondary Thoracotomy</th>
<th>Number Resections</th>
<th>Number Secondary Thoracotomies</th>
<th>Per-Cent Secondary Thoracotomies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonectomy</td>
<td>372</td>
<td>22</td>
<td>5.7</td>
</tr>
<tr>
<td>Lobectomy</td>
<td>973</td>
<td>23</td>
<td>2.5</td>
</tr>
<tr>
<td>Segmentectomy</td>
<td>753</td>
<td>20</td>
<td>2.8</td>
</tr>
<tr>
<td>Mechanical resection with aid of UKL</td>
<td>548</td>
<td>17</td>
<td>3.0</td>
</tr>
<tr>
<td>Total</td>
<td>2646</td>
<td>82†</td>
<td>2.9</td>
</tr>
</tbody>
</table>

†6 secondary rethoracotomies
Hemorrhage After Pulmonary Resection

Figure 1: Three examples of different types of blood loss through bleeding as basic indications for secondary thoracotomy.

toma is removed manually, by an aspirating pump or with the help of fenestrated forceps. If the internal bleeding is multilocular, the inner surface of the chest wall is lined with gauze and systematic hemostasis is gradually carried out by two or three control inspections of the sites of bleeding or potential bleeding, such as lymph nodes, bronchial stump, pulmonary ligaments, intersegmental veins and mechanical sutures. As a rule, the secondary thoracotomy should be done by the original operator, who will probably be able to find the site of bleeding more easily.

Results
In most cases, the course of secondary thoracotomy was uneventful, and its beneficial effect was often noticeable during operation when the patient's condition improved visibly after removal of a large hematoma or ligation of bleeding blood vessels. This is evidenced by the results of the analysis of one of the symptoms of improvement of cardiovascular function, namely rise of the systolic blood pressure in the course of secondary thoracotomy. In 22 secondary thoracotomies in the course of which more than 750 ml. of blood clots or liquid blood was removed, the arithmetic mean of the rise in systolic pressure is distinctly higher five minutes after removing the hematoma, compared with the values before beginning the procedure (Fig. 2). In 16 other cases, however, in which besides hematoma a bleeding blood vessel with gaping lumen was found at operation, removal of the hematoma alone failed to raise the blood pressure. Significant rise, or

<table>
<thead>
<tr>
<th>Table 2—Extent of Resection and Time of Secondary Thoracotomy</th>
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<tbody>
<tr>
<td><strong>Secondary thoracotomy in Hours After Resection</strong></td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>Pneumonectomy</td>
</tr>
<tr>
<td>Lobectomy</td>
</tr>
<tr>
<td>Segmentectomy</td>
</tr>
<tr>
<td>Mechanical resection with aid of UKL</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
even return to normal of the blood pressure, occurred after ligation of the bleeding vessel. (Fig. 2). Rzepski has called this phenomenon the "vasoligation reflex."

After segmentectomy open bleeding vessels usually had the form of interrupted branches of intersegmental veins, bleeding from transected adhesions of the thoracic wall was second, followed by bleeding from intercostal and bronchial arteries.

The thoracic wall was also a main source of extensive parenchymatous, multipunctate bleeding. It is noteworthy that during rethoracotomies after removal of the whole lung, in 76 per cent of cases the source of bleeding was found in the thoracic wall.

Immediate favorable effects and cessation of bleeding were observed after 60 secondary thoracotomies (79 per cent). In seven cases (9.2 per cent) death ensued as a result of the hemorrhage; in one of these cases, secondary thoracotomy had been performed twice.

In nine cases (11.8 per cent) in spite of scrupulous ligation of blood vessels, bleeding continued and in five cases thoracotomy was performed for a third time before bleeding stopped. In four cases in which we were convinced that another operation would be useless, conservative treatment was instituted and the loss of blood was compensated by transfusion of fresh and preserved blood. In two of these patients, hematomas developed in the chest which failed to undergo resorption during several months' observation, providing additional support to the view that postoperative bleeding should be approached actively.

**Table 3**

<table>
<thead>
<tr>
<th>Place of bleeding</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic wall</td>
<td>34†</td>
</tr>
<tr>
<td>Lung tissue (v. v. insegm.)</td>
<td>11</td>
</tr>
<tr>
<td>Bronchial artery</td>
<td>4</td>
</tr>
<tr>
<td>Pericardiophrenic artery</td>
<td>2</td>
</tr>
<tr>
<td>Azygos vein</td>
<td>2</td>
</tr>
<tr>
<td>Hilar lymph nodes</td>
<td>2</td>
</tr>
<tr>
<td>Mediastinum</td>
<td>2</td>
</tr>
<tr>
<td>Tissue in mechanical suture UKL</td>
<td>1</td>
</tr>
<tr>
<td>Not found</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
</tr>
</tbody>
</table>

† 7 from intercostal arteries
In summary, it may be concluded from the reported cases of severe postoperative hemorrhage that secondary thoracotomy effectively puts a stop to the bleeding and allows removal of the hematoma from the thorax (Fig. 3). In one case, immediate rethoracotomy allowed direct massage of the heart, the action of which was arrested by the sudden massive hemorrhage.

Complications after secondary thoracotomy, such as bronchial fistula, nonspecific empyema and suppuration and dehiscence of the operative wound are discussed in a separate communication.

There were seven deaths connected with the hemorrhage, constituting 9.3 per cent of the number of patients operated, that is 8.5 per cent of the secondary thoracotomies that were performed. According to the literature, deaths follow secondary thoracotomy because of bleeding in as many as 23 per cent of cases. Of the deaths observed in our series, four occurred after cortico-pneumonectomies, one after lobectomy with thoracoplasty, one after mechanical resection from the apical segment of the lower lobe and one after mechanical resection from the apico-posterior segment.

The mean time elapsing from the termination of the resection to rethoracotomy in the fatal cases was four and one half hours, and mean blood loss was 4.7 liters. Hence, the hemorrhages were severe and sudden, and immediate rethoracotomy was clearly indicated. Waiting would have been an error, because in six of the seven fatal cases, the site of bleeding found at rethoracotomy was as follows: in two cases a bronchial artery, in two cases transected blood vessels in adhesions of the thoracic wall, in one case the azygos vein, and in one case an intercostal artery. In spite of early rethoracotomy, the condition of the patients was grave; in six cases, the blood pressure was not measurable before administration of noradrenaline. Before undertaking rethoracotomy, all the available methods of restoring cardiovascular function were applied, blood loss was replaced and coagulant therapy was administered with the purpose of improving the patient's condition before operation. In only one case, the rethoracotomy was performed too late. This case occurred nine years ago, at a time when water-seal drainage was not used after pneumonectomies, so that the loss of blood was not accurately assessed.

In one case, the loss of blood was miscalculated, being considered to amount to about 900 ml. and transfusion was not performed before rethoracotomy. As a result, when the thorax was opened, massive transfusion of blood in the patient whose body weight was low led to pulmonary edema and death. On analyzing this case, it was concluded that in patients with low body weight was low led to pulmonary edema and death. On analyzing this case, it was concluded that in patients with low body weight, immediate rethoracotomy was clearly indicated.
weight in whom the loss of blood was not sudden, rapid transfusion of about 1 L. of blood may cause pulmonary edema, even if the heart muscle is healthy.

One woman died after secondary thoracotomy probably as a result of fibrinolysis. In this case, beneficial effect of the operation could not be expected. In all the other patients, immediate operation was vitally indicated. The situations were grave, and there was nothing to be lost. Analysis of the whole material of hemorrhages led to the conclusion that introduction of secondary thoracotomy as routine procedure, in place of conservative therapy, distinctly diminishes the fatality rate in cases of hemorrhage.19

DISCUSSION
In copious hemorrhage, when the patient's condition is grave, the choice of the best time to perform secondary thoracotomy is a difficult and responsible decision. On the one hand, it is desirable to operate upon the patient in compensated condition. On the other hand, unnecessary delay in undertaking rethoracotomy, if the bleeding continues, threatens hemorrhagic shock and may nullify the benefit of the operation. (Fig. 4).

If possible, the development of grave condition of the patient after pulmonary resection should be prevented. With growing experience in this Clinic, the tendency to early secondary thoracotomy has prevailed (Fig. 4). This conclusion has been based on the observation that when the rhythm of blood loss is such as described under indication 2, unless secondary thoracotomy is performed within eight hours, a large hematoma and consequently greater blood loss develops, often leading to hemorrhagic shock.

Since 1960, we have observed smaller mean losses of blood during secondary thoracotomies, which are performed earlier. Before 1960, spontaneous cessation of bleeding was awaited more often, especially in cases in which a large hematoma was not demonstrated radiographically. If hemorrhage persisted or stagnation of blood in the thorax was observed, secondary thoracotomy was performed under much more difficult conditions, among others as a result of copious loss of blood. Preserved blood which is not always fresh, being transported from afar, must be transfused and may lead to diminished clotting ability of the blood.20 Earlier rethoracotomy avoids excessive loss of blood and helps break the subsequent vicious circle of hemorrhage.

POSTOPERATIVE HEMORRHAGE
Disorders of blood clotting; transfusion of preserved blood:

When discussing hemorrhages, problems of prophylaxis cannot be omitted, especially since some severe hemorrhages are the result not of inadequate hemostasis, but of

![Figure 4: Blood loss and time of secondary thoracotomy in years.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21436/ on 06/26/2017)
HEMORRHAGE AFTER PULMONARY RESECTION

Volumr be thoroughly examined in therapy in tuberculous patients. Aminoca-
proic acid or fibrin administered may markedly diminish the intensity of bleeding. This therapy may be carried out independently, especially in cases of fibrinolysis, or it may be combined with secondary thoracotomy.

**Summary**

1. Secondary thoracotomy allows direct finding of the site of bleeding in 70 per cent and control of the hemorrhage in 80 per cent of cases.

2. Deaths after secondary thoracotomy are due less to the operation itself than to its delayed execution, especially in cases with severe irreversible cardiovascular failure and hemorrhagic shock.

3. In many cases, early secondary thoracotomy prevents the formation of hematoma in the thoracic cavity and excessive loss of blood, and their dire consequences.

**Resumen**

1. La toracotomía secundaria permite descubrir directamente el origen de la hemorragia en el setenta por ciento de los casos y el control de la misma en el ochenta por ciento.

2. La mortalidad consecutiva a la toracotomía secundaria es debida al retardo en su ejecución, mas bien que a la operación en sí, especialmente en casos de insuficiencia cardiovascular grave irreversible y de shock hemorrágico.

3. En muchos casos la toracotomía secundaria precoz impide la formación de hematoma en la cavidad torácica y la pérdida excesiva de sangre y sus consecuencias.

**Resumé**

1. La réintervention par thoracotomie permet de trouver directement le point de saignement chez 70% et permet de faire cesser l'hémorragie chez 60% des malades.

2. Les décès qui surviennent après réintervention par thoracotomie sont dus moins à l'opération elle-même qu'au retard dans son exécution. Ceci est spécialement vrai dans les cas qui s'accompagnent de graves insuffisances cardiovasculaires irréversibles et de chocs hémorragiques.

3. Dans bien des cas une réintervention précoce par thoracotomie évite la constitution d'un hématome dans la cavité thoracique et une perte excessive de sang, ainsi que les conséquences que peuvent entraîner ces conditions pour le malade.

**Zusammenfassung**

1. Eine sekundäre Thorakotomie ist imstande, den Herd der Blutung in 70% der Fälle direkt zu ermitteln und die Blutung in 80% der Patienten auch zu beherrschen.

2. Todesfälle nach sekundärer Thorakotomie sind weniger der Operation selbst zur Last zu legen als ihrer verspäteten Durchführung, besonders in Fällen mit schweren irreversiblem cardiovaskulären Versagen und hámorrhagischem Schock.

3. In vielen Fällen verhindert eine frühzeitige sekundäre Thorakotomie die Bildung von Hämatomen in der Thoraxhöhle und den exzessiven Blutverlust mit allen sich daraus für den Patienten ergebenden Konsequenzen.

**References**

1. **Ermolajew, B. P.**; "Wnutri-pleuralnyje Krwo-
toczenia Posle Radikalnych Operacji Na Log-

2. **Marx, F. W. and Steele, J. D.**; "Early Sec-
ondary Thoracotomy Following Pulmonary Re-

3. **Langer, J., Czeverkewski, K., Mieszkowski, 
J. and Plaka, W.**; "Comparison of Rethora-
cotomy and Conservative Treatment in Cases 
of Postoperative Hemorrhage After Pulmonary 

4. **Szapkin, W. S.**; "O Krwotoczenii Pri Oper-