The Clamshell Incision: An Improved Approach to Bilateral Pulmonary and Mediastinal Tumor

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Median sternotomy has been the accepted approach for dealing with mediastinal tumors or bilateral pulmonary disease, but exposure to the lower lobes and to mediastinal tumors extensively involving a hemithorax is often limited. Based on the reported experience from double-lung transplantation, we explored the use of clamshell incisions for these difficult problems. From March 1991 to December 1993, we prospectively studied the utility of clamshell incisions in 90 patients for the following indications: bilateral pulmonary metastases (62 patients), primary lung carcinoma with mediastinal involvement (13 patients), primary tumors of the mediastinum (14 patients), and mesothelioma (1 patient). Bilateral anterior thoracotomies with a transverse sternotomy (clamshell incision) were employed in 71 patients and a unilateral anterior thoracotomy with partial or complete median sternotomy (hemiclamshell incision) was used in 19 patients. For closure, we used pericostal sutures and sternal wires, usually augmented by sternal K-wire stents or Steinmann pins to prevent sternal override. Exposure to all areas of the mediastinum, pericardium, pleura, and lung was excellent. Specifically, the clamshell incision afforded markedly better access to lower lobe disease and hemithoracic extension of mediastinal disease than that possible with median sternotomy. There were no deaths or significant morbidity, and all patients tolerated the incisions well without mechanical respiratory difficulties. There was one wound infection. There was no late sternal override and the cosmetic results were found to be excellent during a follow-up of 2 to 33 months. We conclude that clamshell incisions constitute an improved surgical approach for the management of bilateral pulmonary or combined pulmonary and mediastinal disease.

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Median sternotomy has been the accepted surgical approach for the management of mediastinal tumors and bilateral pulmonary disease. However, it may not afford adequate exposure to the lower lobes or of mediastinal tumors that extend into a hemithorax.

In the early days of cardiac surgery, the heart was approached by a transverse (crossbow) transsternal incision [1]. It was occasionally used as an access to mediastinal tumors or both lungs, but was virtually forgotten as the median sternotomy became the standard access for cardiac procedures. Median sternotomy also became favored as the approach for the removal of most mediastinal tumors and the resection of bilateral pulmonary disease when synchronous or sequential bilateral thoracotomies were not used [2–4].

Based on the experience gained from the use of transsternal bilateral anterior thoracotomy for double-lung transplantation [5, 6], 3 years ago we began to prospectively assess the use of such an incision and its variations for the surgical management of bilateral pulmonary disease, extensive lung tumors involving the mediastinum, and large mediastinal tumors. This consists of a transsternal incision combined with bilateral anterior thoracotomies, which we refer to as a *clamshell incision* (Figs 1, 2), or a unilateral thoracotomy combined with a median sternotomy, which we call a *hemiclamshell incision* (Figs 3, 4).

Material and Methods

Patients and Procedures

From March 1991 to December 1993, clamshell incisions were used for tumor resections in 90 patients (59 men, 31 women; age range, 16 to 79 years; median age, 51 years). A clamshell incision was used in 71 patients and a hemiclamshell incision in 19.

We have used these incisions for the surgical management of bilateral pulmonary metastatic disease (62 patients), large mediastinal tumors with extension into a thoracic cavity (14 patients), and primary pulmonary or pleural tumors with mediastinal involvement (14 patients). The procedures performed through these incisions comprise, in descending order: multiple wedge resections (62); more extensive pulmonary resections such as segmentectomy/lobectomy or bilobectomy (16) or pneumonectomy (4) for the removal of primary pleural or pulmonary tumors; resection of mediastinal tumors (14); resection of involved vascular structures including superior vena cava (2) and subclavian artery (2); and resection of the chest wall (4).

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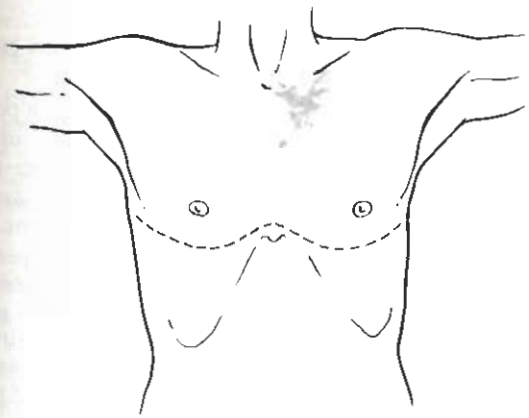

Fig 1. Clamshell incision, made with the patient lying supine.

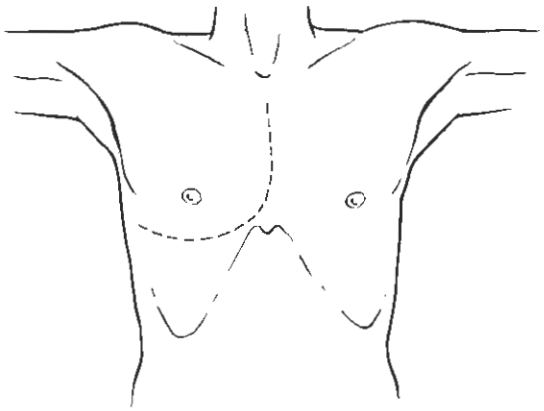

Fig 3. Hemiclamshell incision, made with the patient lying supine.

Technique

CLAMSHELL INCISION. To make the clamshell incision, the patient is placed supine on the operating table and general anesthesia is induced. A double-lumen endotracheal tube is preferred. Both of the patient's arms are usually abducted and placed on arm boards extended laterally, but may be flexed to 90 degrees and anchored on the ether screen. The skin is incised in a curvilinear fashion along the inframammary crease to the anterior axillary line, but may be extended farther posteriorly to expose the lower lobes or the posterior mediastinum. The fourth interspace is entered for the resection of bilateral pulmonary metastases, but a higher interspace may be required for mediastinal tumors. The incision is brought across the sternum at the level of the interspaces entered on either side. The chest cavity is exposed by anterior retraction of the ribs utilizing two Finochietto retractors or a modified Gollgher retractor. The pleural reflections along the anterior mediastinum are divided to expose the mediastinal structures. After the intrathoracic procedure is completed, the sternum is approximated using two or three sternal wires. K wires or Steinmann pins can be placed across it in the marrow to prevent overriding. Ribs can be approximated in the usual fashion using pericostal sutures.

HEMICLAMSHELL INCISION. To make the hemiclamshell incision, the patient is positioned supine, usually with the ipsilateral operative side elevated, depending on whether posterior extension of the thoracotomy is needed. A

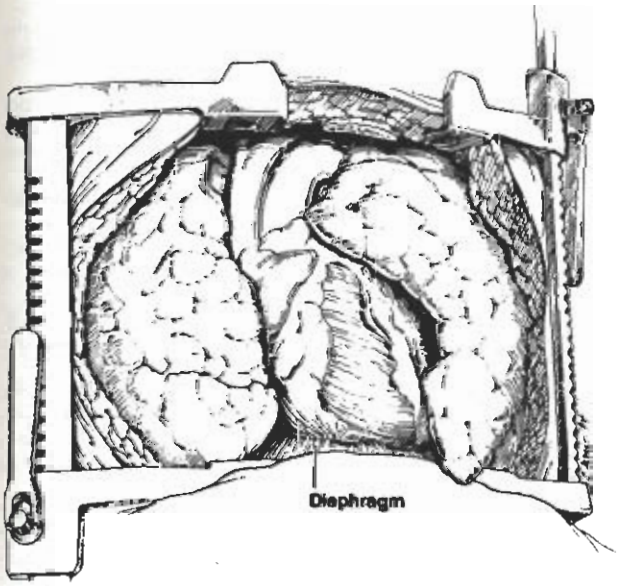

Fig 2. Exposure obtained through a clamshell incision. Two Finochietto retractors are used to spread the ribs on either side of the sternum, revealing both lungs, the anterior surface of the pericardium, major vessels, and a small portion of the diaphragm.

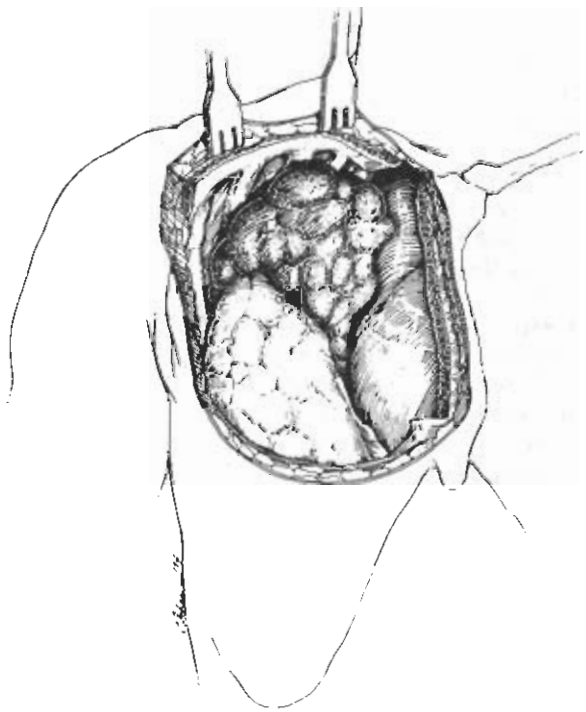

Fig 4. Exposure obtained through a right hemiclamshell incision. The anterior chest wall is retracted cephalad, exposing a mediastinal tumor projecting to the right of the superior vena cava and the cardiac border.

curvilinear inframammary incision is made and continued superiorly as a partial median sternotomy from the level of the intercostal space entered to the sternal notch. Retraction is once again obtained using a sternal retractor or Finochietto retractor or the Favaloro internal mammary retractor. Further exposure can be obtained by removing the inner half of the clavicle after extending the incision laterally (trapdoor). Once the intrathoracic procedure is completed, the incision is closed in a routine fashion using sternal wires and pericostal sutures.

Results

Both clamshell and hemiclamshell incisions have been found to provide excellent exposure to all areas of lung, including the lower lobes (see Fig 3), and to mediastinal structures. We have found this approach especially useful for the management of bilateral metastatic pulmonary nodules in the presence of lower lobe disease, large mediastinal tumors encroaching on one hemithorax, and primary carcinoma of the left lung when superior mediastinal node dissection is required.

One patient suffered wound infection. We have not encountered any sternal override in our patients and none of our patients required ventilatory support or have died. The incisional discomfort proved comparable to that associated with a standard lateral thoracotomy and has not posed a problem either in terms of pain management or the hospital stay.

Comment

The "old-fashioned" transverse sternotomy with bilateral anterior thoracotomy provided excellent exposure of both thoracic cavities for the performance of double-lung transplantation. We have used this approach and its modification in the form of a hemiclamshell incision for the purpose of resecting extensive bilateral pulmonary metastases, large mediastinal tumors extending into one pleural cavity, and a variety of tumors of the lung and pleura invading the mediastinum. We have found the exposure afforded is excellent with minimal morbidity. Cooper [5] has expressed concern about possible sternal override, but this has been prevented by the placement of intrasternal K wires. The procedure is greatly facilitated by single-lung ventilation using a double-lumen tube. Patients tolerate the procedure well and the cosmetic result is acceptable.

We have found that clamshell incisions afford much better exposure to the phrenic, vagus, and recurrent laryngeal nerves than that achieved by a median sternotomy. In the hemiclamshell approach, extending the median sternotomy incision superiorly to the mandible permits excellent exposure of the carotid and vertebral arteries, the subclavian vessels, as well as the jugular and the innominate veins, and also provides exposure of the brachial plexus and lower cervical spine to the T2 vertebral body, allowing remarkable access to anteriorly placed apical tumors [7, 8].

Surgical resection of pulmonary metastases is a potentially curative therapy [9, 10]. However, the best surgical approach to effect complete resection of these metastases is still controversial. Staged lateral thoracotomies have the advantage of affording access to metastatic lesions irrespective of the location. The median sternotomy permits resection of bilateral metastases in a single operation and is less painful [11–14], but not all lesions are made accessible, particularly those located posteriorly and centrally. The clamshell incisions combine the benefits of a single procedure with the ability to access all disease.

We conclude that clamshell incisions are a better surgical approach than sternotomy or bilateral sequential thoracotomies for the resection of multiple pulmonary metastases or combined pulmonary or mediastinal disease.

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DISCUSSION

DR HERMES C. GRILLO (Boston, MA): I had not meant to comment, but want to observe that we have found the clamshell to be a very useful incision for complex carinal and tracheal problems in which, for example, we have to remove half the trachea, the carina, and the left lung. When we started using it many years ago, some patients had difficulty breathing postoperatively because of pain. Since epidural analgesia has come available, we have found that the incision is really quite benign in those first few days.

The other incision, the hemiclamshell, or "trapdoor," incision, I used in my first carinal resections. We have since abandoned it for reasons which had to do with the surgical procedure, not with the incision itself. However, it offered exposure of the entire trachea, including posterior exposure to the esophagus and the back of the carina. For the upper end of the trachea, we have found a collar incision rather than an oblique slash in the neck is preferable. It provides superb access all the way to the hyoid bone with a nice cosmetic result. I can attest to the usefulness of both incisions.

DR BAINS: Thank you, Dr Grillo. I agree with you that, with the availability of epidural catheters, pain control is now much better. In our patients, the pain has proved to be no worse, maybe a little less, than that associated with the standard posterolateral thoracotomy. You are right that a transverse incision in the neck would provide better cosmetic wound healing. However, to expose the lower cervical spine down to the T2 vertebral body, we continue the vertical incision to the angle of the mandible.

DR FREDERIC W. GRANNIS, JR (Arcadia, CA): There has been a description in the Japanese literature of using this clamshell incision to carry out contralateral mediastinal node dissections for left lung cancers. Have you had experience with that application of this procedure?

DR BAINS: Yes, we have used this incision for the management of contralateral mediastinal nodal involvement. Our numbers of patients are too few to permit answers to any questions, but, yes, it has proved to be a very useful incision for doing careful mediastinal node dissections. We have usually employed a hemiclamshell incision for this.