Biatrial Approach to Cardiac Myxomas: A 30-Year Clinical Experience

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Early surgical intervention for atrial myxomas mitigates morbidity and usually offers cure. The operative approach to resect these tumors is controversial. The purpose of this study was to review our experience with the biatrial approach between 1964 and 1994. The location of the myxoma was left atrium in 17 and right atrium in 3. Mean preoperative New York Heart Association functional classification was 2.7. Surgical approach to the tumor was biatrial in all patients. There were no perioperative strokes, myocardial infarctions, or deaths. Mean follow-up was 7.5 years (range, 2 mo to 27 years) with a postoperative New York Heart Association functional classification of 1.4. One late death occurred, which was unrelated to the myxoma. Advantages of biatrial approach include (1) definition of tumor pedicle by direct visualization, (2) minimal manipulation of the tumor, (3) adequate margins of excision, (4) inspection of all heart chambers, and (5) secure closure of the atrial septal defect. Long-term follow-up demonstrates the efficacy of this operative approach to atrial myxomas.

The first successful resection of a left atrial myxoma using cardiopulmonary bypass was performed in 1954 by Clarence Craaford [1]. With the advent of echocardiography more of these tumors have been diagnosed and resected even in asymptomatic patients. As experience with atrial myxomas has been obtained, several surgical principles have evolved. In an effort to achieve a safe, efficacious operation that adheres to these principles several operative approaches have been described [2-4]. The approach to atrial myxomas include an isolated left or right atriotomy, right atriotomy with transseptal incision, and biatrial approach.

The operative approach used to resect these tumors should provide excellent exposure and safe excision. The purpose of this study was to review one institution’s experience with the biatrial approach to cardiac myxomas over a 30-year period.

Material and Methods

Study Population

Between 1964 and 1994 there were 20 patients (13 female, 7 male) who underwent resection of an atrial myxoma using cardiopulmonary bypass at West Virginia University Hospitals. The average patient age was 55 years (range, 18 to 76 years). The tumor was located in the left atrium in 17 patients and in the right atrium in 3 patients.

All patients had symptoms related to their myxoma with a mean duration of symptoms of 12.5 months. The most common symptoms included dyspnea on exertion (61%), generalized malaise (55%), palpitations (33%), syncope (22%), chest pain (17%), and transient ischemic attacks (17%). These symptoms are similar to those in other series [5-9]. Physical examination revealed a murmur in 72% of patients and a pathognomonic “tumor plop” in 30% of these patients. One patient with a right atrial myxoma had peripheral edema. Preoperative New York Heart Association functional class assessment was class I, 2; II, 7; III, 7; and IV, 4 [10].

One patient suffered from the complex cardiac myxoma syndrome, which is characterized by cardiac myxomas, lentiginosis, and occasionally pituitary or testicular tumors [5]. This patient had two myxoma recurrences in the right atrium, 2 and 9 years after the initial successful removal of a right atrial myxoma. Both of these recurrences did not involve the interatrial septum and were approached via a right atriotomy. They are not reported in this series. One patient had an associated secundum atrial septal defect and has been reported previously [11].

Laboratory analysis revealed a low-grade leukocytosis in 24% of patients. An increased sedimentation rate and gamma globulinopathy were identified in 19% of patients. Anemia was present in 17% of patients, and no patient had thrombocytopenia.

The diagnosis of atrial myxoma was made by echocardiography in 95% of patients (Fig 1). Cardiac catheterization was performed in 95% of patients and revealed mild to severe pulmonary artery hypertension in 52% of patients. Electrocardiographic findings included nonspecific ST-T wave changes and occasional premature atrial complexes. All patients were in normal sinus rhythm.
Fig 1. A representative transthoracic echocardiogram showing a large left atrial myxoma prolapsing through the mitral valve. This tumor arose from the base of the right inferior pulmonary vein.

Fig 2. The biatrial incisions are shown here. The left atrial incision (inferior dotted line) is only large enough to identify the site of origin of the tumor. The right atriotomy (superior dotted line) is larger to excise the septum and myxoma and to remove tumor.

Fig 3. A right-angle clamp introduced through the left atriotomy provides a reference point for the surgeon to begin excision of tumor and interatrial septum.

Fig 4. The myxoma is resected en bloc through the right atriotomy with an adequate rim of interatrial tissue.

except 1 who had a right bundle-branch block. Documentation of an atrial myxoma prompted early operative intervention in each patient. The average time to operation, after diagnosis, was 72 hours (range, 2 hours to 11 days).

Surgical Technique

Exposure of the heart and great vessels was provided by a median sternotomy (17) or right thoracotomy (3). Bicaval cannulation was used for left atrial tumors with care being taken to minimize manipulation of the heart to avoid tumor embolization. Cardiopulmonary bypass was instituted with moderate hypothermia and topical saline-slush cooling. Hyperkalemic crystalloid or blood cardioplegia was delivered concomitantly depending on the surgeon's preference.

A left atriotomy was made posterior to the interatrial groove (Fig 2). This incision was usually 3 to 5 cm and was not used to mobilize the tumor. The diagnosis and location of the myxoma were confirmed.

A right atriotomy was performed and the right atrium and ventricle were explored for the possibility of tumor extension from the left atrium or for a second myxoma. A right-angle clamp or the operator's finger was introduced under direct visualization through the small left atriotomy and provided a reference point that allowed right atrial excision of the tumor with an adequate rim of interatrial septum (Fig 3).

A full-thickness excision of a portion of the interatrial septum was performed and the tumor removed through the right atriotomy (Fig 4). Myxomas not attached to the septum underwent a subendocardial or full wall thickness resection with pericardial patch closure of the defect. The left heart chambers were carefully inspected for tumor fragments or other myxomas. The mitral valve was inspected for valvular damage or annular dilatation secondary to the myxoma.

The surgically created atrial septal defect was closed primarily or with a pericardial patch (Fig 5). The left and
right atriotomies were closed and the left ventricle vented before the discontinuation of bypass. Although of theoretical concern only, all shed cardiac blood and irrigant were discarded to avoid return of any myxoma cells to the circulation.

If the tumor was located in the right atrium, the inferior vena cava usually was cannulated via the transfemoral route and the superior vena cava cannulated directly. An oblique right atriotomy was performed. The left atrium subsequently was opened, the tumor and surrounding septum were excised, all heart chambers explored, and the atriotomies closed.

Follow-up
Patients were followed up between 1964 and 1994 with a range of 0.2 years to 27 years (mean follow-up, 7.5 years). Routine echocardiography was not part of the follow-up. Cumulative duration of follow-up was 152 patient-years, and no patient was lost to follow-up. Survival data were obtained through clinic visits or via telephone from April to May 1994.

Results
Surgical Findings
A biatrial approach was employed for resection of all tumors. Seventeen myxomas (85%) were located in the left atrium. Fifteen were attached to the interatrial septum, one to the posterior wall, and one at the base of the right inferior pulmonary vein. Three right atrial myxomas (15%) all were attached to the interatrial septum.

Procedures associated with resection of the myxoma included coronary artery bypass grafting (2), mitral valve repair (2), and closure of a secundum atrial septal defect (1).

Pathologic examination of all tumors showed the average dimension to be $4.3 \times 3.3 \times 2.6$ cm. Fifty percent of the tumors were friable or myxoid and gelatinous. The majority were sessile-based or had a broad stalk or base of attachment. These required wide interatrial septum excision and placement of a pericardial patch. All excisional margins showed no evidence of tumor.

Early Results
There were no perioperative deaths. There was one significant atrial dysrhythmia that required cardioversion. Two patients required reoperation within 24 hours of the primary procedure. In the first, who had a right atrial myxoma resection, a coagulopathy developed necessitating reoperation for bleeding. The second patient was transferred to our institution with a postintubation tracheal laceration and a clinical picture of congestive heart failure. Repair of the tracheal laceration was performed initially. Postoperatively, the cause of the congestive heart failure was found to be secondary to a large, prolapsing left atrial myxoma. After resection of the myxoma, a coagulopathy developed with clinical signs of cardiac tamponade, which necessitated reoperation.

Postoperative cardiac rhythm at the time of hospital discharge was normal sinus in 95% of patients. One patient had a first-degree atroventricular block, and the patient with repair of the secundum atrial septal defect had a right bundle-branch block.

Late Results
There was one death in the late follow-up period. This patient had a fatal myocardial infarction 2 years after the successful resection of a right atrial myxoma. Preoperative cardiac catheterization had failed to demonstrate significant coronary atherosclerotic disease.

Postoperative New York Heart Association functional classification was determined within 6 months of their operation. All patients were in functional class I or II with an average of 1.4.

Comment
Atrial myxomas are uncommon but with early surgical treatment morbidity is mitigated and cure is usually possible. The surgical approach to atrial myxomas should (1) allow minimal manipulation of the tumor, (2) provide adequate exposure for complete resection of the tumor, (3) allow inspection of all four heart chambers, (4) minimize recurrence, and (5) be safe and efficacious. There is still considerable controversy, however, concerning the most appropriate surgical approach to achieve the above surgical principles. This point is emphasized by reviewing the largest series of operative approaches to left atrial myxomas, including this one, reported within the past six years (Table 1). The frequency of the various operative approaches are biatrial, 38%; left atriotomy, 34%; and transseptal, 28%. Clearly, the optimal operative approach to the atrial myxoma lacks uniformity.

Advocates of the left atriotomy approach [4, 12, 13] consider the exposure to be adequate and have demonstrated low recurrence rates and safety of this technique. Interestingly, 34% to 85% of patients had a subendocardial, not full-thickness, resection of the interatrially based tumor [4, 12]. This approach prevents inspection of all four cardiac chambers. In addition, a left atriotomy alone
The right atrial incision allows inspection of the right tumor. We do not attempt to mobilize the tumor through only large enough to confirm the diagnosis of myxoma, and to assess the friability and size of the tumor, to identify the tumor pedicle in the case of left atrial tumors are not attached to the interatrial septum. Finally, the left cardiac chambers can be inspected adequately for mitral valve abnormalities, other tumors, and tumor fragments.

This study supports the biatrial approach to atrial myxomas. Exposure of the myxoma was excellent in all cases. Adequate excisional margins of the tumor were confirmed histologically. There were no significant intraoperative difficulties using this approach even when other procedures were performed. As supported by others, we found no significant mitral valve abnormalities that required mitral valve replacement. All cases of mitral incompetence were managed with either commissural sutures or ring annuloplasty.

Perhaps one of the most compelling reasons to employ a biatrial approach is provided by evaluation of the pathologic specimens. The average size of the myxomas was $4.3 \times 3.3 \times 2.6 \text{ cm}$, which is not insignificant. In addition, the majority of myxomas were friable and sessile, or pedunculated with a broad base. Evaluation of our pathologic data is supported by Burke and Virmani [6], who reported the Armed Forces Institute of Pathology experience with cardiac myxomas. He found 70% of tumors were sessile or had a broad base. In addition, 60% of the tumors were friable or irregularly surfaced, and these were responsible for 94% of embolic symptoms. The difficulty in managing large myxomas, incomplete inspection of all chambers for tumor emboli, and inadequate surgical excisional margins have been criticisms of either the left atrial or transseptal approach or both. The biatrial approach allowed adequate exposure to remove these lesions en bloc, thus avoiding tumor embolization and potential seeding of tumor cells.

Recurrence of cardiac myxomas is 4% to 5% in most larger series. We had one recurrence (5% incidence) in a patient who had a right atrial myxoma and also had the complex myxoma syndrome. This patient's pathologic margins of excision were negative for these lesions en bloc, thus avoiding tumor embolization and potential seeding of tumor cells.

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the safety and efficacy of the biatrial approach to atrial myxomas. The postoperative New York Heart Association functional class was class I or II in all patients. There was one death, unrelated to the myxoma, in this series. These long-term findings of the efficacy of the biatrial approach have been supported by others [7, 8].

In conclusion, this study supports the clinical efficacy, safety, and long-term success of the biatrial approach to atrial myxomas. The biatrial approach adheres to all of the identified surgical principles for the successful removal of these tumors.

References

DISCUSSION

DR CURTIS G. TRIBBLE (Charlottesville, VA): I appreciate the opportunity to review the manuscript ahead of time. Doctor Jones and Dr Murray were gracious enough to send it to me. Certainly removing atrial myxomas is something that all heart surgeons enjoy not only talking about but also doing. The attractions of myxoma resection include the facts that there is no controversy about the indications, there is a complete cure in almost all cases, there is a low complication rate, and certainly there is an attraction to dealing with some mysterious, primordial jelly. The biggest problem, really, is that there are not enough atrial myxomas to go around. I just pulled out my office file without even running a literature search and I found 26 series over the last 10 years reported by surgeons representing every southern state, most big centers around the world, and many foreign countries. I reviewed these articles to see what questions we should be asking at this time about myxomas.

Should we inspect all chambers? The answer may be different now that we have transesophageal echocardiography, which may be even better than visual inspection. What sort of incision should we use? Should we use one atriotomy; should we use two atriotomies? In this article Jones and associates discuss the transseptal technique, but I think in their series most of those transseptal incisions are probably not the transplant transseptal incision popularized for mitral valve operations in recent years. The biggest question remains, really, should these tumors be "totally" resected or can they be "shaved," and this series does not answer that question at all. Shaving must be okay and occasionally is necessary, we all know. My last case was one that involved the atrial wall right beside the mitral valve, and we had to shave it off. It would be nice to know whether that technique is adequate, and the truth is that in the big series from the Cleveland Clinic, Mayo Clinic, Peter Bent Brigham, and several other centers, in every case reported in which they shaved off the myxoma, there were no reported recurrences. So one must conclude that this technique is acceptable and complete resection of the septum is not always necessary and, practically speaking, is not always possible.

I do like the approach presented by Jones and associates, however. It is easy using these biatrial incisions to figure out where the myxoma is and how best to resect it. Thus, I am left with a couple of questions for Dr Jones and associates that I hope will allow us to take advantage of the perspective they have gained over the three decades of this series.

One question is, should we have some sort of different type of work-up preoperatively for those who have the familial types of syndromes? There was one in this series with recurrence, and they apparently are somewhat identifiable by odd skin pigmentation and the paraneoplastic syndromes that go with them. Second, what about new advice on preoperative or intraoperative transesophageal echocardiography? Is echocardiography being used to avoid the need for a complete four-chamber inspection? And the final question is, have Jones and associates used the transplant transseptal incision more recently now that this incision has become a more popular approach to the left atrium?

DR JONES: Thank you, Dr Tribble, for your review of the manuscript and your comments. With respect to your first question, I do not think the preoperative work-up should be different for the patient with the complex myxoma tumor syn-
drome. In that patient, however, I think every attempt should be made to completely resect the tumor. Tumor “shaving” as you suggested has at least a 12% incidence of incomplete resection margins as reported by Sellke and associates [1]. Theoretically these tumors, if incompletely resected, could recur.

Second, we have used transesophageal echocardiography intraoperatively in the last several patients and agree that it is helpful in evaluating all four chambers. Continued use of this modality may obviate the need for four-chamber inspection in the future. Currently, there is no substitute for palpation and inspection of the chambers.

Finally, we have not used the transplant transseptal incision for approach to these tumors.

DR CHARLES F. REUBEN (Milwaukee, WI): I have a question. Some of these tumors have a much narrower base than the actual size of the tumor. Do you make a very large septal incision to try and get them out that way? And as a corollary, I am a little concerned about the size of the left atrial incision. That is the route we would prefer to remove the tumor and then also inspect the left atrial chamber to be sure that none of the tumor has broken off, especially in the very friable ones.

DR JONES: Tumors that have a very small base do not require complete interatrial septum excision. An adequate margin of tissue around the base of the tumor would be fine.

We attempt to remove the tumor through the right atriotomy. The left atriotomy can be extended, if necessary, to evaluate the left atrium, ventricle, and mitral valve. In our experience, extension of the left atriotomy incision rarely is needed.

DR SAMUEL H. SADOW (Palm Beach Gardens, FL): I enjoyed your paper very much. I am not sure whether it is the luck of the draw or what, but the last few atrial myxomas that we have seen down in south Florida have been so large that I have some reservations about their removal by any technique other than a transseptal superior approach, which we have been quite comfortable with in the last few years in attempting to repair as many mitral valves as possible. As a matter of fact, I am quite confident that with the so-called giant myxomas, there is no other way to get them out without morselating them by any approach other than the transseptal superior approach. I noticed you mentioned the four-chamber inspection. The last chamber that is important to inspect or to drain would be the ascending aorta. If these things break off, they are obviously at great risk for emboli.

DR JONES: Addressing your last comment first, we agree that tumor embolization can be catastrophic and that careful inspection of the left ventricle and aorta is very important. In removal of the large myxomas, the important technical point of the biatrial approach is the left atriotomy is not used to mobilize the tumor for fear of causing tumor embolization. The left atriotomy is used only to localize the site of origin of the tumor so it can be excised. We have had no trouble, and we have had some large tumors, in safely excising and removing them en bloc without morselization. I am sure your extended vertical transseptal approach also would be effective to remove these tumors safely.

Reference