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Minimally Invasive Replacement of Ascending Aortic Aneurysms: Intermediate Term Results

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ABSTRACT

Background: Minimally invasive techniques have gained recent interest in the realm of cardiac surgery. This report describes our initial experience with graft replacement of ascending aortic aneurysms using a superior mini-sternotomy approach.

Methods: Between March 1997 and October 1997, four patients underwent operation for ascending aortic aneurysm via superior mini-sternotomy approach. There were two female and two male patients, ranging in age from 52 to 62 years (mean 53.7 ± 7.6). All patients had the stigmata of Marfan's syndrome. Mean diameter of the ascending aortas was 6.1 ± 0.9 cm. Composite graft replacement with coronary reimplantation was performed in all cases. In one patient hemiarch replacement was performed under total circulatory arrest. There was no hospital (30-day) mortality. Mean aortic cross clamp and cardiopulmonary bypass times were 63 ± 14.1 minutes (range 44 to 78) and 116.7 ± 43.3 minutes (range 81 to 177), respectively. One patient was re-explored for bleeding.

Results: Lengths of hospital stay ranged from 5 to 7 days (mean 5.5 ± 1). Patients were followed-up for at least 18 months. One patient suffered a fatal stroke in her third postoperative month. All surviving patients were in NYHA Class I at the sixth postoperative month and thereafter.

Conclusions: Minimally invasive graft replacement of ascending aortic aneurysms can be performed safely and effectively. Long term results are likely to be similar to those of conventional cases performed through a full median sternotomy.

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INTRODUCTION

Minimally invasive techniques have gained recent interest in the realm of cardiac surgery. Various technologies have been introduced into clinical practice, and a minimally invasive approach is defined for almost every operation in cardiac surgery [Chitwood 1998, Gundry 1998]. Among these, minimally invasive replacement of aortic valves via a superior mini-sternotomy has proved to be a safe and effective strategy. This has become our standard approach in operations involving the aortic root. This report describes our initial experience in graft replacement of ascending aortic aneurysms with 18 months follow-up.

MATERIALS AND METHODS

Between March 1997 and October 1997, four patients underwent operation for ascending aortic aneurysm via superior mini-sternotomy approach. There were two female and two male patients, ranging in age from 52 to 62 years (mean 53.7 ± 7.6). All four patients had the stigmata of Marfan's syndrome. Two of the patients were in NYHA Class III; the other two patients were asymptomatic. In three patients, aortic aneurysm was confined to the ascending aorta, terminating below the innominate artery. One patient presented with an ascending aortic aneurysm extending into the aortic arch. Mean diameter of the ascending aortas was 6.1 ± 0.9 cm (range 5 to 7.2). Two patients had severe aortic insufficiency.

Our superior mini-sternotomy approach was based on the technique reported by Gundry [Gundry 1998], with few modifications. A longitudinal skin incision of 6–7 cm was performed starting 2 cm below the suprasternal notch. A "J" type superior mini-sternotomy ending at the third or the fourth right intercostal space was performed. Arterial cannulation was achieved via the right subclavian artery in

one patient, and via the femoral artery in three patients. Venous return was accomplished through the right atrial appendage in one patient. In three patients, inferior displacement of the right atrium by the aortic aneurysm precluded right atrial cannulation. In these patients, the femoral vein was used for venous return, together with a pulmonary artery vent. Retrograde cardioplegic delivery was not used. Moderate hypothermia (28–30° C) was used in three patients, whereas deep hypothermia (18° C) was used in the other. All operations were conducted under transesophageal echocardiographic guidance.

A composite graft was created before aortic cross clamping, by suturing a 25 mm St. Jude Medical™ aortic valve to a 30 mm Hemashield™ Dacron graft. After aortic cross clamping, the aneurysm was completely resected with the aortic valve. Buttons of right and left coronary ostia were prepared for coronary reimplantation. The composite graft was sewn into the aortic annulus with 2-0 polypropylene continuous suture. Coronary reimplantation was performed by sewing the coronary ostia to the appropriate holes created in the graft with 7-0 polypropylene continuous suture in two cases. In two cases, Cabrol modification was used with an 8 mm Hemashield™ graft [Jault 1994]. Distal anastomosis was performed under aortic cross clamping in three patients. In one patient hemiarch replacement was performed under total circulatory arrest (see Figure 1 ◎).

RESULTS

There was no hospital (30-day) mortality. Mean aortic cross clamp and cardiopulmonary bypass times were 63 ± 14.1 minutes (range 44 to 78) and 116.7 ± 43.3 minutes (range 81 to 177) respectively. One patient was re-explored for bleeding. The reexploration was conducted through the same incision. There was no active bleeding site. Lengths of hospital stay ranged from 5 to 7 days (mean 5.5 ± 1). One patient suffered a fatal stroke in her third postoperative month. All surviving patients underwent echocardiographic investigation at the 2nd, 6th, 12th, and 18th postoperative months, without evidence of pathological result. All surviving patients were in NYHA Class I at the 6th postoperative month and thereafter.

DISCUSSION

In the last decade, refinements in surgical technique and graft material have simplified ascending aortic aneurysm repair. This group of patients is being operated on worldwide with gratifying results, similar to those with isolated aortic valve replacement [Stowe 1998]. With the establishment of the safety and efficacy of minimally invasive techniques for the surgical intervention of the aortic valve [Gundry 1998], we deemed it feasible to replace an ascending aortic aneurysm in a similar fashion.

Although cosmesis should not be a primary goal regarding a complex operation, it is still an important issue. The cosmetic result of this operation yields superior patient satisfaction. More importantly, a minimal skin incision and a mini-sternotomy result in less tissue dissection and less bleeding [Karagoz 1999]. This is particularly advantageous in a patient with Marfan's syndrome, who probably has a higher chance of undergoing re-operation.

Graft replacement of an ascending aortic aneurysm via a superior mini-sternotomy is technically similar to a full sternotomy approach, regarding perfection and simplicity of the operation. Essentially the same operative techniques are used. Complete resection of the ascending aorta renders the aortic root suitable for composite graft replacement with coronary reimplantation, as the aortic annulus and the coronary ostial buttons can be freely mobilized. We preferentially use a custom made composite graft, with a large (30 mm) graft and a smaller valve (25 mm), for greater ease in direct coronary reimplantation [Karagoz 1991]. However, when the coronary ostia are close to the aortic valve annulus, we use the Cabrol modification [Jault 1994], as we have in two instances in this report (see Figure 2 ◎). In addition, distal anastomosis can be performed easily via superior mini-sternotomy approach, with or

Figure 1. Graft replacement of an ascending aortic aneurysm via superior mini-sternotomy.

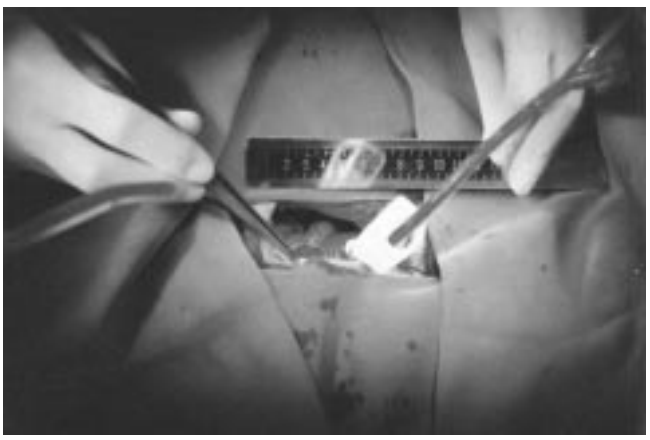

Figure 2. Replaced ascending aortic aneurysm via superior mini-sternotomy using Cabrol modification.

without aortic arch involvement.

Although the operation can be conducted with ease, there are certain disadvantages of this approach. The most prominent drawback is the inaccessibility of the right atrium, which often precludes its cannulation. We also consider groin cannulation for venous drainage a drawback of a less invasive procedure [Karagoz 1999]. In addition, lack of retrograde cardioplegic delivery may be considered a suboptimal aspect of the procedure.

Follow-up of these patients at 18 months yielded satisfactory results. One neurologic death in the third postoperative month was probably not related to the operative methodology, although a necropsy could not be obtained at that time. This female patient underwent an uncomplicated operation confined to the ascending aorta. The remaining patients are asymptomatic and their long-term outcome will likely be similar to that of conventional cases.

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REVIEW AND COMMENTARY

1. Editorial Board Member MY17 writes:

One aspect of the technique, which should have been mentioned, is the need for external defibrillator pads as internal defibrillation is difficult through minimal access.

I have one question for the authors. Regarding the case they needed to go back in for bleeding, did they convert to a full sternotomy?

2. Editorial Board Member YT31 writes:

Is less exposure really worth the avoidance of incising the last two inches of the thinnest part of the sternum?

3. Editorial Board Member SC389 writes:

I would like to know how cardioplegia was administered — direct coronary?

4. Editorial Board Member XA5 writes:

This is a reasonable report of a technique that some will be interested in adding to their armamentarium. I do have a few small semantic and philosophical issues that I'll outline below.

1.) I really don't like the term "minimally invasive" for operations like this. So, I'd suggest an accurate term like "ascending aortic replacement using hemi-sternotomy" which describes exactly what was done and leaves the reader to decide how invasive the operation seems to be.

2.) I am concerned about a number of shortcuts taken by the surgeons in order to keep the incision small, such as avoidance of retrograde cardioplegia; use of the Cabrol technique in these first-time repairs (most are saving that the technique for re-do's these days, fretting over persistent anecdotal reports of problems with the small grafts used in this technique); and lack of access to the pericardium to achieve drainage (many have noted a fairly high incidence of postop pericardial effusions in these patients if no provision is made for egress of fluid from the pericardium to pleural spaces).

3.) I'd like to know more about the re-exploration reported in one patient. What was the site of bleeding and route of re-exploration? Could the bleeding have been a consequence in any way of the limited exposure?

4.) Was the stroke in one of the patients with a Cabrol graft?

5. Editorial Board Member AR11 writes:

When compared to the John's Hopkins data offered by Gott et al., the very high rate of complication and late death in this (admittedly small) series cannot come close to approaching the results of the Hopkins group. Additionally, the need for 2 incisions, whether in the axillary artery cannulation or femoral approach, obviates the argument for better cosmesis. This is especially noteworthy when, for anuerysmal disease (as opposed to dissection), the entire operation may be done via a single sternotomy, cannulating the ascending aorta or arch distal to the aneurysmal segment and then under DHCA, resecting the cannulation site, and recannulating the graft. I think this manuscript will stimulate interest in the readers but fear its application will generate more problems than good.

Authors' Response by Haldun Y. Karagoz, MD :

I would like to thank all the reviewers for their comments. As already stated, this is a short report and the sole intention of this report is to document the feasibility of managing ascending aortic aneurysms via a superior ministernotomy approach. Therefore, detailed descriptions of the surgical technique or operative and postoperative variables are not included in the manuscript, as they can be found elsewhere [Gundry 1998, Karagoz 1999].

We would not like to speculate on the degree of invasiveness of this procedure and the exact words to define it — at least not in the official journal of the International Society for Minimally Invasive Cardiac Surgery. Nonetheless, we have to point out that scientific terms should not be regarded as marketing tools, and the principal goal of a

minimally invasive procedure should be to perform a perfect operation.

We do not consider this procedure a hemi-sternotomy procedure, as only a small portion of the sternum is separated from the main body of the sternum, and the clavicular-sternal-rib cage continuity is preserved in a significant manner (Figure 3 ◎). Looking at the figure, we think that this preservation is worth less exposure.

We did not find it necessary to use external defibrillator pads. In fact, in most of our cases using various minimally invasive approaches, spontaneous sinus rhythm ensues, following terminal warm cardioplegia (37°C), which is administered in large doses. In the rare instances where defibrillation is required, we use pediatric internal defibrillators without significant difficulty (Figure 4 ◎).

In the cases reported here, we administered cardioplegia directly into the coronary ostia. After coronary reimplantation was completed, cardioplegia was delivered through the grafts, whether the Cabrol technique was used or not. This maneuver was important, as the anastomoses could be checked for bleeding at that time.

Also, we do not think the Cabrol technique is a drawback for a primary ascending aortic aneurysm repair. The technique is being used in first-time operations (and has been) with success for years [Jault 1994]. The Cabrol technique was indeed used in the patient who suffered a stroke in her third postoperative month. However, there is no indication that the stroke was related in any way to the aortic operation or the Cabrol modification. We were notified that her hemodynamics were very stable after the stroke, without a clue of myocardial ischemia. Moreover, all of us can remember anecdotal reports regarding problems originating from coronary reimplantation sites, as well as Cabrol grafts.

It is a common observation to encounter high incidences of postoperative pericardial effusion after operations of this type. We had documented previously that this complication was due to application of ultra-fast-tract protocols [Karagoz 1999], rather than lack of access to the pericardium.

We think that proposing deep hypothermic circulatory arrest for an operation that can be performed using moderate hypothermia is inappropriate and in fact a very invasive approach. Also, we have no intention of comparing our modest report to the series of others. However, it should be noted that there is no scientific basis of extracting bleeding and late death rates from a series of only four cases and than comparing these rates with the rates of previously published reports. To our knowledge, this is the first report of a minimally invasive treatment of ascending aortic aneurysms with at least a 1.5-year follow-up.

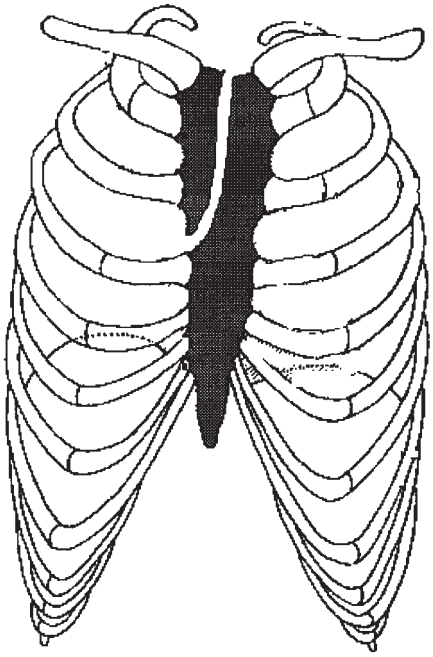

Figure 3. J-type superior mini sternotomy used in minimally invasive replacement of ascending aortic aneurysms.

Figure 4. Internal defibrillation in minimally invasive replacement of ascending aortic aneurysms.