Cannulation of the right axillary artery for surgery of acute type A aortic dissection

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Abstract

Objective: The optimal choice of the arterial inflow site during operations for type A aortic dissection is not clearly defined. The aim of the prospective study was to identify whether cannulation of the right axillary artery instead of the femoral artery may improve the results of surgery for acute type A aortic dissection.

Methods: Seventy consecutive patients were operated on because of acute type A aortic dissection from January 2000 to February 2002. The only difference in surgical strategy was the site of arterial cannulation: the right axillary artery was used in 20 patients [axillary group] and the left femoral artery in 50 patients [femoral group]. All patients had aortic surgery with open distal anastomosis during deep hypothermic arrest and retrograde cerebral perfusion. The mean age was 58.7 ± 12 years with a range from 28 to 88 years (axillary group, 56.6 ± 13 years; femoral group, 59.4 ± 12 years; P = 0.435). Preoperatively evident organ malperfusion was identified in five (25%) patients of the axillary group and in seven (14%) of the femoral group.

Results: There was no perioperative death. The hospital mortality rate was 5.0% for the axillary group and 22% for the femoral group (all patients, 17%). Major neurological complications occurred postoperatively in 5% of patients from the axillary group (one out of 20 patients) and in 8% of patients from the femoral group (four out of 50 patients) (all patients, 7%).

Conclusion: Cannulation of the right axillary artery improved the outcome of surgery for acute type A aortic dissection. However, postoperative complications occurred after both axillary and femoral artery cannulation.

Keywords: Aortic dissection; Right axillary artery cannulation

1. Introduction

A femoral artery, mostly the left one, is the usual site of cannulation for cardiopulmonary bypass in acute type A aortic dissection. When cardiopulmonary bypass is instituted, the direction of arterial flow in the aorta is reversed. This retrograde perfusion through femoral cannulation may elevate the dissected intima causing malperfusion with consequent neurologic injury or abdominal organ ischemia or may cause retrograde embolization from the atherosclerotic aortic wall. In contrast, cannulation of the right axillary artery enables antegrade flow through a true lumen at least in the region of cerebral perfusion. Therefore, cannulation of the axillary artery instead of the femoral artery may avoid cerebral embolization and organ malperfusion and may reduce the rate of neurological and malperfusion complications [1–12].

The aim of this prospective study was to identify whether cannulation of the axillary artery instead of the femoral artery may improve the results of surgery for acute type A aortic dissection. We devote special attention to feasibility of cannulation, local findings in the region of the arterial cannulation and possible complications of the procedure.

2. Patients and methods

Between January 2000 and February 2002, 70 consecutive patients were operated on because of acute type A aortic dissection. In all patients a standard operative technique for acute aortic dissection at our institution was used and the only difference in surgical strategy was the choice of the site for arterial cannulation. In a total of 70 patients, the right

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axillary artery was used in 20 patients [axillary group] and the left femoral artery in 50 patients [femoral group]. The mean age was 58.7 ± 12 years with a range from 28 to 88 years (axillary group, 56.6 ± 13 years; femoral group, 59.4 ± 12 years; P = 0.435). The patients with chronic dissection or aortic dissection after previous open-heart surgery were not considered in this group of patients. The patients operated on without deep hypothermic circulatory arrest were also not included in this study. All patients were operated on an emergency basis immediately after the diagnosis was established. The diagnosis was made on the basis of echocardiography combined with computed tomography in most patients. Aortography or coronarography was not necessary for preoperative evaluation. No specific arteriographic visualization or Doppler assessment of the axillary artery was performed.

The standard operative technique for acute aortic dissection at our institution has been graft replacement of the ascending aorta, inspection of the aortic arch with or without concomitant arch surgery and open distal anastomosis during deep hypothermic circulatory arrest and retrograde cerebral perfusion. The aortic arch was reconstructed with a biological glue and the aortic valve was reconstructed using commissural resuspension. The valve was replaced if it was diseased. This technique was applied in 16 (80%) patients of the axillary group and 32 (64%) patients from the femoral group; composite graft implantation was performed in the others. Composite valve graft replacement was performed in patients with Marfan syndrome or if intraoperatively severe local injury with aortic wall destruction was found. The decision whether or not a composite graft was implanted did not depend on the maximal diameter of the aortic root but was based on the presence of Marfan syndrome or the severity of wall destruction.

Mean extracorporeal circulation time was 227 min (axillary group, 175 min; femoral group, 243 min) with a range from 69 to 665 min (axillary group, 81–259 min; femoral group, 69–665 min). Mean cross-clamp time was 95 min (axillary group, 81 min; femoral group, 99 min) with a range from 44 to 170 min (axillary group, 47–110 min; femoral group, 44–170 min). Mean circulatory arrest time was 28 min (axillary group, 24 min; femoral group, 29 min) with a range from 11 to 66 min (axillary group, 15–43 min; femoral group, 11–66 min).

2.1. Surgical technique

The patient is placed in the standard supine position. The arms are in a horizontal position near the body as for the usual heart procedure. Monitoring of the arterial pressure is performed by placing three arterial lines routinely (in both radial arteries and the right femoral artery). The sequence of the surgical procedure is as follows: right axillary artery is dissected (Figs. 1–5), a median sternotomy is performed, heparin is given intravenously and then the right axillary artery is cannulated. The right axillary artery was always used for cannulation even in patients with no pulse or demonstrated attenuation of the pulse of the right arm. If the artery is found to be dissected, the true lumen is cannulated. Although there are several possible skin incisions for exposure of the right axillary artery we used a deltoideopectoral approach (Figs. 1–3). A subclavicular horizontal approach is frequently used by some surgeons (Fig. 4). Optionally, instead of direct cannulation of the axillary artery, a synthetic graft-to-artery anastomosis with graft cannulation may be used. A 8-mm synthetic graft (Dacron or PTFE) is anastomosed end-to-side to the artery and the
The cannula should lie without tension because retraction of the sternum may produce additional tension on the axillary artery cannula. Next, the pericardium is opened and the right atrium is cannulated with a standard 36 Fr two-stage cannula. Cardiopulmonary bypass is instituted, a left-ventricular vent is placed through a right upper pulmonary vein and the patient is cooled down aggressively to a rectal temperature of 16°C.

During the cooling phase the ascending aorta is clamped with a Crafoord clamp, the proximal part of the ascending aorta is longitudinally incised, the false lumen is mostly opened, then the true lumen is incised and the cardioplegic solution instilled directly into the coronary ostia. The aortic basis is reconstructed with a biological glue and the aortic valve is reconstructed using commissural resuspension. The supracoronary graft replacement of the ascending aorta is performed with the proximal anastomosis being done during the cooling phase. The arch is inspected and the distal anastomosis is performed during deep hypothermic circulatory arrest and retrograde cerebral perfusion. For retrograde cerebral perfusion a small (12–16 Fr) metal-tipped curved venous cannula is inserted into the superior vena cava and connected to a separate perfusion line. A separate roller pump was adjusted for a flow of 200–500 ml/min according to the central venous pressure (target pressure 20 mmHg). Cardiopulmonary bypass is re-started using the right axillary artery for arterial perfusion. At the end of the procedure, after cardiopulmonary bypass is ceased and the hemodynamic state of the patient is stable, the axillary artery is decannulated and the artery is closed using a 6-0 Prolene continuous suture. Optionally, the ascending aortic graft is cannulated and the perfusion given antegradely and then the axillary artery is decannulated and reconstructed.

3. Results

There were no perioperative deaths. The hospital mortality was 5.0% for the axillary group (one patient died because of preoperative aspiration and consequent pneumonia) and 22% for the femoral group (11 of 50 patients). The hospital mortality for all patients was 17% (12 of 70 patients). Preoperatively evident organ malperfusion was identified in five (25%) patients of the axillary group and in seven (14%) of the femoral group. Only postoperatively evident organ malperfusion occurred in two patients (10%) patients of the axillary group and in eight (16%) patients of the femoral group. Major neurological complications occurred postoperatively in 5% of patients from the axillary group (one from 20 patients) and in 8% of patients from the femoral group (four of 50 patients) (all patients, 7%).

The cannulation of the right axillary artery was successful in all patients even in three very obese individuals. In two patients (10%) we found a partially (not completely circumferential) dissected axillary artery. Despite involvement by dissection, the true lumen of the right axillary artery...
was cannulated. In two (10%) patients we found increased thickness of the posterior wall of the artery caused by local atheroma. During the surgical procedure we found no injury of the axillary artery or of the brachial plexus. Also, there was no axillary artery or venous thrombosis and no local hematoma, and no ischemia of the arm or intraoperative or postoperative malperfusion of the arm. The wound healing was excellent in all patients.

4. Discussion

Our study showed that cannulation of the right axillary artery instead of the femoral artery may improve the results of surgery for acute type A aortic dissection.

Cannulation of the right axillary artery was feasible in all our patients. Even in very adipose individuals, the cannulation was performed without problems. We performed direct arterial cannulation in all patients. Alternatively, a synthetic graft-to-artery anastomosis with graft cannulation might secure easily cannulation [1,5,6,9,11] such as in patients with small body surface area and therefore a small vessel. Schachner et al. reported that conversion to femoral artery cannulation was necessary in two out of 22 patients. In one patient the conversion was necessary because of significant resistance in the artery during advancement of the cannula and in the another because cardiopulmonary bypass flow was insufficient [12]. We have observed no wound healing problems after cannulation of the axillary artery. As stressed by others, this is an additional advantage in comparison to femoral cannulation [2], with possible complications such as lymph fistula, nerve injuries, hematoma or muscle weakness. We cannulated either the medial or distal arterial but observed no injury of surrounding nerve roots. Baribeau et al. [6] favor cannulation of the proximal part of the artery in order to avoid cervical nerve roots and Sabik et al. [10] used the more lateral part.

An advantage of the cannulation of the axillary artery is that it is not necessary to recannulate the tube graft before reestablishing cardiopulmonary bypass. We used the right axillary artery for cannulation in all our patients. Some authors used the left axillary artery as a primary site for cannulation [1]. However, as in cannulation of the femoral artery, retrograde perfusion through the left axillary artery may further elevate the dissected intimal flap and may cause proximal (truncus brachiocephalicus, left carotid artery) and distal organ malperfusion in patients with entry in the aortic arch. The right axillary artery can also be used for cerebral protection as selective antegrade right carotid artery perfusion [4,6]. Furthermore, right axillary artery cannulation provides another theoretical advantage over cannulation of the left axillary artery because of the possibility of better washing out air bubbles and atherosclerotic debris from the cerebral vessels [7].

Although some considered pulselessness or demonstrated attenuation of the pulse of the arm as a contraindication for ipsilateral cannulation [1], we do not consider it a contraindication. We found in two of our patients a partially (not completely circumferential) dissected axillary artery and, despite dissection, the true lumen was cannulated through the non-dissected arterial wall. Therefore, in the case of complete circumferential dissection of the axillary artery, we could cannulate the true lumen of the artery. However, the incidence of involvement of the axillary artery by a dissecting process is very low [1].

Our study is an observational study because the two groups are not balanced. We found that preoperative malperfusion was more frequent in the group with axillary cannulation but the intraoperative data such as extracorporeal circulation, aortic clamping time and deep hypothermic circulatory arrest are much better for patients undergoing surgery with axillary cannulation compared to the data for the conventional group. These differences might have an impact on early outcome.

Some consider that one of the major advantages of axillary cannulations is the possibility of antegrade cerebral perfusion during deep hypothermic circulatory arrest. However, we used retrograde cerebral perfusion during deep circulatory arrest in order to avoid clamping of the truncus brachiocephalicus. Axillary cannulation in patients with previous open-heart surgery might have some important advantages but we did not consider these patients for this study in which we involved only patients with primary aortic dissection.

The mortality rate of 5% in the group of axillary cannulation is excellent despite the 25% rate of preoperative malperfusion. However, in this small group it is not possible to identify whether the type of cannulation alone is the only important parameter for these excellent results in comparison to the results of the conventional cannulation.

The only possible problem of axillary artery cannulation presents dissection of the subclavian artery with an intimal tear in the brachiocephalic trunk or subclavian artery that can cause retrograde carotid dissection and cerebral malperfusion [8]. It occurs mostly after institution of the natural antegrade flow such as after recannulation of the ascending graft and cessation of the cardiopulmonary bypass through the right axillary artery. However, there is no better solution for this problem and femoral cannulation also does not solve it. The risk of distal malperfusion in such a situation is even greater using femoral cannulation. This problem indicates the need for continuous intraoperative monitoring of the cerebral blood supply [8].

A contraindication for use of the right axillary artery for cannulation is known severe atherosclerotic disease of the axillary or subclavian artery. However, it is also rarely involved in the atherosclerotic process.

Cannulation of the right axillary artery can be applied not only for surgery of type A aortic dissection but also when peripheral cardiopulmonary bypass is planned for descending aortic aneurysms or even in patients with severely calcified or aneurysmal ascending aorta. It avoids retrograde
flow through a diseased aorta and retrograde embolic risk [1–3,9–12]. Furthermore, femoral artery cannulation may not be possible in the presence of peripheral vascular disease such as aortoiliac occlusive disease or atherosclerotic changes of femoral arteries. Therefore, cannulation of the axillary artery has been used in some institutions as a standard surgical strategy [5,8].

Our study has some important limitations. It is an observational study (no randomization) and presents our preliminary experience with a small number of patients. Our good preliminary results need to be confirmed by studies of a larger group of patients.

In conclusion, cannulation of the right axillary artery for acute type A aortic dissection may improve surgical results. The cannulation is technically feasible and safe. It may avoid cerebral embolization and organ malperfusion and, therefore, may reduce the rate of neurological and malperfusion complications.

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References


Appendix A. Conference discussion

Dr D. Jayakar (Chicago, Illinois): I want to know the technicalities of how you cannulated, what type of cannula you used. And when you actually snare the cannula, was there any evidence of limb ischemia and any complications related to it?

Professor Pasic: No, we have no complications related to the cannulation of the right axillary artery. We always cannulated the artery directly, and we always snared the cannulated part of the artery. We used several types of cannula, most of them standard cannulas for femoral artery cannulation. But it’s very important that it be a nonrigid cannula. We used cannulas with a diameter of between 21 and 24 French.

Dr B. Koul (Land, Sweden): My question to you is, do you consecutively cannulate them in the axillary artery, or do you study first CT or by Doppler if the axillary artery or the innominate is involved in the dissection? And what is your present practice?

Professor Pasic: We did not use any preoperative CT or Doppler examinations. We always cannulate the right axillary artery, even if the distal pulse is absent. In this group of patients the decision to cannulate the right axillary artery was made individually. One surgeon performed cannulation of the axillary artery in all patients that he operated on. The present policy at our institution is that the only contraindication for cannulation of the right axillary artery is serious peripheral arterial atherosclerotic disease.

Dr Koul: And my following question would be, in cases you have now, as in two patients you had, dissection in the axillary artery, and your aim was to prevent the malperfusion. So how are you making sure that your cannula is not producing a malperfusion in the right brachiocephalic trunk?

Professor Pasic: We open the axillary artery and open the true lumen and put the cannula into the true lumen. Our intention was to perfuse the true lumen.

Dr Koul: Sure. But do you mean that you are sure that you are not producing more tear distally where you cannot see? I am concerned. That’s how I reflect in my own practice.

Professor Pasic: So the only possibility to produce distal malperfusion in this situation is if you have a dissection of the right carotid artery with distal intimal tear in the carotid artery. This is very rare and in this group of patients we haven’t seen that.

Dr Koul: And my last question is regarding malperfusion, you said you have been studying malperusions in the two groups. How soon after the surgery for the acute type A dissection do you examine these patients for malperfusion and by what method?

Professor Pasic: We look out for malperfusion at all stages. But the question of malperfusion is very difficult immediately after surgery, especially if you think about visceral malperfusion. Therefore in the last few years we have performed immediate angiography if we believe that there is a possibility of visceral malperfusion. Our strategy has differed over time. Recently we have first considered placing an endovascular stent graft alone or in combination with interventional fenestration and, at the least, surgical fenestration.

Dr A. Haverich (Hannover, Germany): I also would like to compliment you on a very nice series and extremely low complication rate in this subset of 20 patients.

I still find the axillary artery somewhat cumbersome prior to operation, get into cannulation, and we have done more than 50 patients now in the sequence where we cannulate the ascending aorta at the time of sternal entry for aortic dissections, and we didn’t find any problems associated with that, especially since the portion of the ascending aorta that is cannulated will be resected anyway afterwards, and like you have done in your series, with an open distal anastomosis. And we in Hannover believe this is the better approach rather than the axillary artery. Could you comment on that?
**Professor Pasic**: Our experience is similar to yours, that at the beginning cannulation of the axillary artery can produce some difficulties. However, for the surgeons who have experience in peripheral vascular surgery, it is easier to cannulate the right axillary artery than the femoral artery.

The second question regarded the cannulation of the ascending aorta. I have no personal experience with this type of cannulation in the case of aortic dissection. We cannulate the right axillary artery and then we clamp the distal part or the middle part of the ascending aorta and during the cooling time we perform the proximal anastomosis in order not to lose time. So for this question, the answer is that I have no personal experience, but thank you very much for your comment.

**Dr M. Song** (Seoul, Korea): When you have the patient with severely obliterated thoracoabdominal aorta in type A dissection, still you’ll use the axillary artery cannulation? We have used the axillary and femoral artery cannulation together. I think it is safer, especially when the patient has some risk of malperfusion injury.

**Professor Pasic**: In our group of patients we had no such patient. And also, our experience is very limited, but our aim is to find out whether cannulation of the right axillary artery is feasible and simple for this type of procedure. Our main result is that it is possible to cannulate the right axillary artery without complications.