A Novel Custom-Made Long Shunt Simplifies the Performance and Improves the Results of Beating-Heart Surgery

(#2003-612938 . . . August 28, 2003)

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ABSTRACT

Background: The occurrence of a snare-related stenosis after beating-heart surgery prompted the search for an alternative method of hemostasis. Because of the shortcomings of commercial coronary shunts a novel custom-made coronary shunting technique was devised. It involves the use of varying lengths of 1.2-mm Silastic tubing secured with a fine silk "tag" suture. The technique of construction and deployment of the shunts is presented. A retrospective comparison of 500 off-pump coronary artery bypass graft (OPCAB) cases done with snares was made with 300 cases using custom-made long shunts (CLS).

Method: Between June 1998 and December 2000, 500 OPCAB surgeries were done using the Platypus stabilizer and Silastic snares for hemostasis. Thereafter, 300 surgeries were done with the same stabilizer but using CLS instead of snares.

Results: The CLS group had a perioperative infarction incidence of 1.6% compared with 4.4% in the snare group. Other measured parameters remained unchanged, but there was a profound, but subjectively noted, reduction in the incidence of hemodynamic instability in the shunted cases.

Conclusion: The best method for control of coronary bleeding during beating-heart surgery remains controversial. There is increasing evidence that snares can cause artery damage and spasm. Shunting avoids this problem while enhancing hemodynamic stability and facilitating accurate anastomoses. The case against shunts is based mainly on inconvenience but this problem has been substantially negated by the introduction of the CLS technique.

INTRODUCTION

It is indisputable that a good blood-free field is essential for accurate coronary grafting. It seems that some surgeons snare the target artery and use a shunt only occasionally and others use shunts wherever possible.

Presented at the Sixth Annual Meeting of the International Society for Minimally Invasive Cardiac Surgery, San Francisco, California, USA, June 19-21, 2003.

Received August 27, 2003; accepted August 28, 2003.

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I have developed a new type of shunt, the custom-made long shunt (CLS). After performing off-pump coronary artery bypass grafting (OPCAB) using snares as the principal method of hemostasis on 500 patients, I performed 300 OPCAB surgeries using shunts as the exclusive method. For these cases, the CLS was used. The technical aspects of the CLS are described in this article.

MATERIAL AND METHODS

This analysis examines 800 consecutive cases of OPCAB surgery. After the decision to embrace beating-heart surgery as the principle method for coronary grafting in my practice, the incidence of OPCAB quickly rose to >90%, and for those patients whose cardiac output was compromised by exposure, normothermic cardiopulmonary bypass assist was used, with no aortic cross clamping.

The first group of patients (snare group, n = 500) underwent surgery between June 1998 and December 2000. The second group (CLS group, n = 300) underwent surgery after December 2000. All patients were operated on by the author and were consecutive. The groups were not matched. Myocardial infarction was defined as a troponin level of 0.2 or above. The results were evaluated over a 30-day period.

Most patients were on aspirin before surgery. They were operated, through a full or hemisternotomy, using pericardial incisions and retraction sutures for positioning and a Platypus (www.beating-heart.com) reusable stabilizer. The field was cleared with a saline wash. A cell saver was used in multigraft cases. In 62% of cases total arterial revascularization was achieved using internal thoracic and radial arteries.

In the snare group, Retract-o-Tape (Quest Medical, Allen, Texas, USA) 18G snares were used for proximal and distal bleeding control during anastomoses. The proximal snare was crossed and secured to cleats on the stabilizer foot while the distal one was uncrossed and tightened only enough to control back bleeding. It was also slotted into cleats on the foot. A variety of commercial shunts were used in 2% of cases because of heart block or other signs of significant ischemia.

In the CLS group, CLS were used for control of bleeding. Approximately 20% of arteries needed an additional gentle proximal snare around the shunted artery. The shunts were made from various lengths (2-5 cm) of tube derived from the snare material, a soft, white silastic tube, 1.2-mm outer diameter, 0.7-mm inner diameter. Each piece of tube was furnished with a 5o silk tag suture, passed close to the edge in of the middle of the tube, and secured with a vascular clip

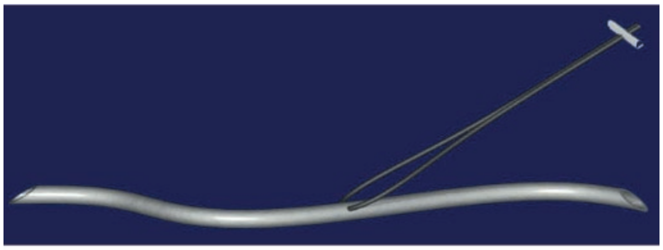

Figure 1. Tag suture in place, secured with vascular clip.

(Figure 1). To insert the shunt, a short arteriotomy was made and the whole length was inserted into the artery, usually proximally but if close to a stenosis, distally (Figures 2 and 3).

The length of tube chosen depended on the size of the coronary artery. If the tube was too long, it was cut to size while in the artery (Figure 4). After the tube was completely inserted with a final push from forceps or a probe (Figure 5), it was pulled back with the tag (Figure 6). The arteriotomy was then enlarged (Figure 7). Occasionally, particularly when a large initial cut had been made in the artery or the bevel was not oriented outward, it was necessary to put counterpressure on the arteriotomy with a bunt instrument to prevent the shunt from reemerging during retraction. Residual bleeding usually stopped by the time the graft was prepared. If the field was still obscured a gentle proximal snare was used.

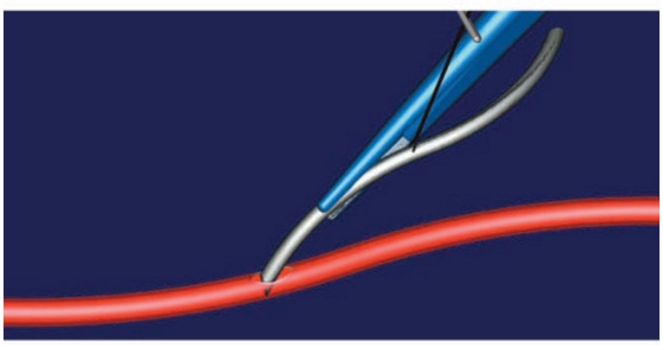

Figure 2. Initial insertion through short arteriotomy.

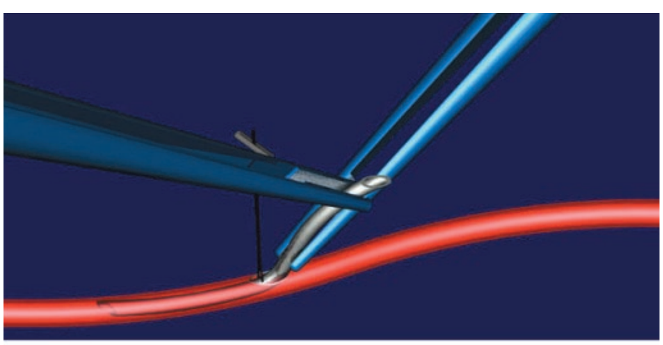

Figure 3. Further insertion.

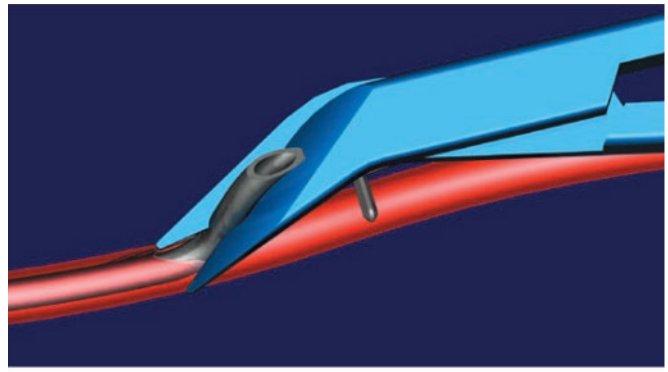

Figure 4. Excess trimmed in artery.

Because the shunt was so soft, all the anastomotic sutures were placed before extraction and any stitches accidentally put into the shunt were simply pulled out.

These shunts were used for all grafts in the CLS group because, in practice, it was found that arteries too small to take them were not candidates for grafting.

RESULTS

Results are shown in the Table.

DISCUSSION

Because the groups were neither matched nor randomized, no scientifically valid conclusion can be made from this study and no statistical analysis can have any meaning. Technical advances in surgery commonly do not lend themselves to randomized trials because surgeons, having experienced a new technique, often are so convinced of the benefit that they feel that subjecting patients to the old method would be unethical. For example, after having a zero occurrence of strokes in more than 900 cases in which the cross clamp was eschewed, I could never consider using it again.

The results in the snare group were very respectable, but I was puzzled by the occurrence of infarctions in good arteries for which I was convinced I had done an excellent anastomosis.

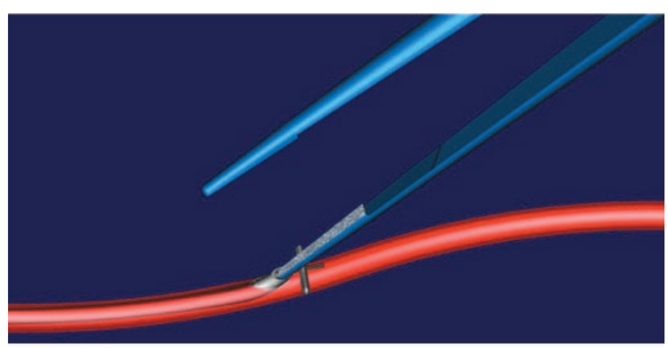

Figure 5. Final insertion with forceps or probe.

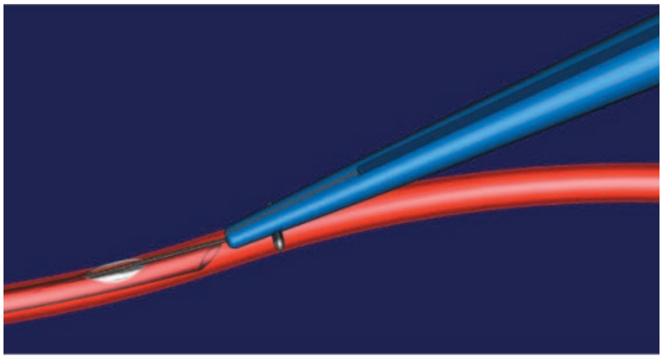

Figure 6. Retraction of shunt across arteriotomy.

Results for Surgery Using Snares versus Custom-Made Long Shunts (CLS)

	Snare Group (n = 500)	CLS Group (n = 300)
Median age	68 y	69 y
Grafts/patient	2.8	2.9
Arterial grafts	55%	84%
No aortic anastomosis	43%	76%
Mortality	4 (0.8%)	3 (1.0%)
Parsonnet mean	3.1	3.1
Stroke	0	0
Infarction	22 (4.4%)	5 (1.6%)

There was experimental [Hangler 2001] and clinical [Demaria 2001] evidence that snaring or clamping of coronary arteries, particularly in the presence of atheroma, could cause endothelial damage. It was also reported, however, that snaring did not cause endothelial dysfunction [Perrault 1997]. I thought the nature of the snares and their gentle application would negate these dangers. A surgery in which a complete proximal occlusion occurred at the snare site in a large coronary artery, however, made the need to abandon snaring obligatory.

I found the existing shunts required a long arteriotomy and were not suitable for small arteries. A long arteriotomy is a serious disadvantage when using arterial conduit for sequential grafting, and many coronary arteries are smaller than 1.5 mm. The CLS shunts were serendipitously discovered when I tried using pieces of the snare material for shunts. The nature of the silicon elastomer and the size were just right for the job. The only shortcoming was the absence of larger sizes, necessitating the addition of a gentle proximal snare in some cases in which even the shunt's extra length could not prevent flooding of the field. In this situation, however, the snare only closed the artery around the shunt, rather than completely occluding it. Two larger sized tubes (1.35 mm and 1.5 mm) have been especially manufactured and are proving to be very effective in early clinical trials.

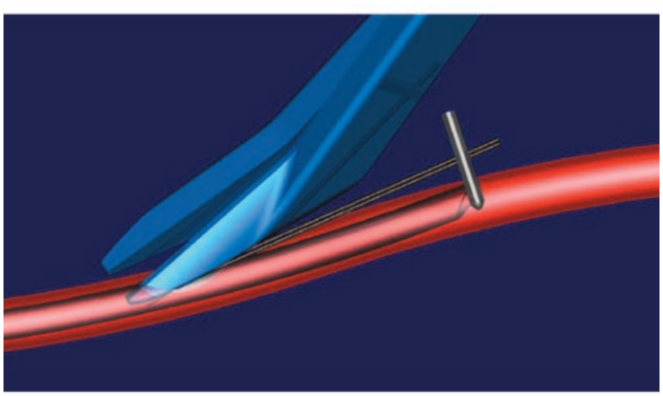

Figure 7. Enlargement of arteriotomy.

The infarction rate dramatically declined in the snare group, and hemodynamic stability improved substantially. Infarcts that occurred were associated with diffuse disease or questionable anastomoses. The improved stability of the patients during surgery was presumably due to the absence of segmental ischemia. Most cases are now managed with volume loading and beta-blockers alone. Inotropes and pressors are rarely required.

It could be argued that the improvements in the shunt group were related to leveling of the learning curve, but it seems to be more than a coincidence that improved results suddenly occurred with the deployment of shunts in 99.7% of arteries.

Rivetti and Gandra [Rivetti 1998] reported 501 off-pump cases using shunts. Their results were similar to mine. They and others comment on improved hemodynamics [Franzone 1977] and describe, in detail, the manifest advantages of shunts over snares [Yeatman 2002]. Nevertheless, it seems many surgeons still predominately use snares. Perhaps the increased convenience afforded by CLS will persuade them to reevaluate their technique.

REFERENCES

Demaria RG, Fortier S, Carrier M, Perrault LP. 2001. Early multifocal stenosis after coronary artery snaring during off-pump coronary bypass in a patient with diabetes. J Thorac Cardiocasc Surg 122:1044-5.

Franzone AJ, Wallsh E, Stertzer SH, DePasquale NP, Bruno MS. 1977. Reduced incidence of intraoperative myocardial infarction during coronary bypass surgery with use of intracoronary shunt technique. Am J Card 39:1016-20.

Hangler HB, Pfaller K, Andretta H, Daupunt OE, Bonatta JO. 2001. Coronary endothelial injury after local occlusion on the human beating heart. Ann Thorac Surg 71:122-7.

Perrault LP, Menasche P, Bidouard JP, et al. 1997. Snaring of the target vessels in less invasive bypass operations does not cause endothelial dysfunction. Ann Thorac Surg 63:751-5.

Rivetti LA, Gandra SMA. 1998. An intra-luminal shunt for off-pump coronary artery bypass grafting: report of 501 cases and review of the technique. Heart Surg Forum 1:30-6.

Yeatman M, Caputo M, Narayan P, et al. 2002. Intracoronary shunts reduce transient intraoperative myocardial dysfunction during off-pump coronary operations. Ann Thorac Surg 73:1411.