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Bilateral skeletonized mammary artery grafting: experience with 560 consecutive patients

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Abstract *Objective.* To test the hypothesis that the skeletonized technique of harvesting the internal thoracic artery improves the surgical results of bilateral internal thoracic artery grafting, we reviewed our 7-year experience with this technique.

Methods. Between July 1987 and December 1994, 560 patients received bilateral internal thoracic artery grafts and 236 additional grafts (average 2.6 ± 0.6 anastomoses per patient). There were 515 men (92%) and the average age was 56.9 ± 8.8 years. There were 63 diabetic patients (11.3%). During harvesting, the internal thoracic arteries were always totally skeletonized from the surrounding tissues without the use of electrocautery.

Results. Postoperative complications included reoperation for bleeding, 17 patients (3%), phrenic nerve paresis, 17 patients (3%), acute respiratory distress syndrome, 9 patients (1.6%), digestive compli-

cations, 8 patients (1.4%), neurologic complications, 6 patients (1.1%), and sternal complications, 6 patients (1.1%). No wound complications were observed in diabetic patients. The hospital mortality rate was 1.6% (9 patients, 2 cardiac causes). The early patency of internal thoracic artery grafts was 97.9%. Follow-up averages 29 ± 20 months. There were 14 late deaths (4 cardiac causes). Angina recurred in 51 patients and the maximal stress test was abnormal in 47 patients.

Conclusion. Bilateral internal thoracic artery grafting with skeletonized harvesting carried low postoperative mortality and morbidity and therefore it could be applied routinely without the fear of increased complication rate. [Eur J Cardio-thorac Surg (1996) 10:971–976]

Key words Bilateral internal thoracic artery grafting · Coronary surgery · Internal thoracic artery · Skeletonized ITA

Introduction

Patients receiving the left internal thoracic artery (ITA) to the left anterior descending coronary artery (LAD) have increased longevity and greater freedom from ischemic cardiac events than patients having saphenous vein grafts only [12, 17]. However, few studies show that the use of both ITAs results in a better cardiac event-free survival than the use of the left ITA alone [5, 7, 10]. To achieve

such an improvement in cardiac event-free survival, one should question at what „price“ this can be reached in terms of hospital mortality and morbidity. The aim of grafting both ITAs is to obtain similar hospital mortality and morbidity rates as the use of only the left ITA. In this regard, the mobilization of the ITA as a skeletonized vessel seems to reduce postoperative morbidity and, particularly, the incidence of sternal wound infections [8, 11]. We present a retrospective analysis of our 7-year experience with 560 patients receiving bilateral skeletonized ITA grafting.

Patients and methods

From July 1987 to December 1994, 560 patients underwent coronary revascularization with both ITAs and supplemental grafts, operated on by the same surgeon (OB). This patient group represents 60% of the entire patient population receiving coronary bypass grafts during the period in question. There were 515 men (92%) and 45 women (8%) ranging in ages from 25 to 78 years. The mean age was 56.9 ± 8.8 years. Coronary risk factors in the series included hypertension in 204 patients (36.4%), hyperlipidemia in 323 patients (57.7%), smoking in 375 patients (67%), positive family history in 128 patients (23%) and previous myocardial infarction in 273 patients (49%). Diabetes was found in 63 patients (11.3%) but only 5 patients had insulin-deficient diabetes. Only 24 patients had no risk factors (4.3%). Preoperative angiography demonstrated triple-vessel disease in 392 patients (70.0%) and double-vessel disease in the remaining 168 patients (30.0%). Left main coronary artery disease (greater than 50% stenosis) was present in 140 patients (25%). Ejection fraction was greater than 50% in 344 patients (61%), between 30% and 50% in 118 patients (21%) and less than 30% in 20 patients (4%). A record of the ejection fraction was unavailable in 78 patients (14%). In all, 1367 coronary grafts and 1474 anastomoses were performed, with an average of 2.63 ± 0.64 grafts per patient. Each patient received bilateral ITA grafts and in 225 patients (40%) additional grafts were constructed with autologous vein (212), right gastroepiploic artery (12) and radial artery (23). The types of conduit and corresponding recipient arteries are shown in Table 1.

Operative technique

The ITAs were exposed through a median sternotomy incision using a Delacroix-Chevalier retractor (Delacroix-Chevalier, Paris, France). After incision of the endothoracic fascia, the ITA was skeletonized from its surrounding tissues. Occlusion of major side branches of the ITA was obtained with metallic clips (Weck, Baxter, Division Edwards CVS, Maurepas, France). The ITA was mobilized from near its origin proximally to its bifurcation *and the time required was approximately 30 min for one ITA*. This mobilization was realized with scissors, without electrocoagulation to avoid thermal damage to the arterial wall of the ITA. The ITA mobilization was facilitated by the use of optical magnification ($\times 4.5$) to avoid injury of the vessel and intramural hematoma. During the ITA mobilization, the surgeon tried to preserve the pleura. This can easily be done on the left side but is more difficult on the right side. If the pleura are open, a large external thoracic artery, if present, is clipped on the thoracic wall to prevent the steal phenomena. The ITAs were wrapped with a papaverine-soaked sponge. Following systemic heparinization, the ITAs were divided distally and free flow was assessed grossly. In the presence of a sluggish bloodstream, the ITA was again inspected and, if necessary, divided short of a previously unnoticed lesion. It was very seldom that serious intramural injury with impaired flow forced the abandonment of the graft. For all patients in stable condition, an intravenous diltiazem infusion (4 mg/h) was carried out before ster-

notomy and was maintained during the surgical procedure and the postoperative period. No intraluminal ITA manipulation was performed. Coronary anastomosis was performed with continuous 8-0 polypropylene suture.

The destination of ITA grafts and anastomoses are illustrated in Table 1. Free ITA anastomoses represented 14.5% of the total number of ITA anastomoses. The proximal anastomosis of the free ITA grafts was performed by direct suture to the aorta (running stitch of polypropylene 7-0). After the disappointing patency rate of the free ITA grafts reported by Dion [9], we restricted the free ITA grafts to sites where it was impossible to use in situ grafts. The cardiopulmonary bypass was conducted with moderate hypothermia ($30^{\circ}\text{--}32^{\circ}\text{C}$) and myocardial protection during aortic cross-clamping was achieved using cold ($4^{\circ}\text{--}5^{\circ}\text{C}$) antegrade and retrograde coronary sinus cardioplegia. The retrograde cardioplegia was repeated every 20 min to maintain the septal temperature between 10°C and 15°C . Aortic root venting was used in all cases. Mean cardiopulmonary bypass time was 85.7 ± 28.0 min (range: 41–272 min) and the mean duration of aortic cross-clamping was 56.3 ± 15.0 min (range: 30–118 min).

Early catheterization

At the beginning of our experience, a repeat catheterization was proposed to patients 10 days after operation to assess the early ITA graft patency with the skeletonized technique of ITA harvesting. After the good results obtained with this method, we proposed this early catheterization for detecting technical dysfunctions that could be corrected by percutaneous transluminal angioplasty (PTCA).

Follow-up

Perioperative data were obtained from the patient's hospital record. Follow-up information was collected from the patient's personal physician, from responses to mailed questionnaires or by telephone interview with surviving patients or family members. Data collected were entered into a computer-assisted reporting system.

Results

Postoperative complications

The postoperative complications are reported in Table 2. The total incidence of postoperative complications for the series was 12% (67 patients). Atrial arrhythmias occurred in 103 patients (18%). The mean postoperative time of assisted ventilation was 29.25 ± 73 h (3 h–62 days), median

Table 1 Coronary arteries grafted and type of conduits (LAD left anterior descending artery, DIAG diagonal artery, MARG marginal artery, RCA right coronary artery, PDA posterior descending artery, ITA internal thoracic artery, RGE right gastroepiploic artery, RA radial artery)

Conduit	LAD	DIAG	MARG	RCA/PDA	Other	Total
Left ITA	212	127	287	–	11	637
Right ITA	309	17	41	46	8	421
Free left ITA	5	3	12	–	3	23
Free right ITA	9	7	60	76	5	157
Vein	3	8	20	164	6	201
RGE	–	–	–	12	–	12
RA	–	3	–	18	2	23
Total						1474

Table 2 Hospital complications (ARDS acute respiratory distress syndrome)

Complications	
Perioperative myocardial infarction	17 (3%)
Bleeding requiring reoperation	17 (3%)
Neurologic	6 (1.1%)
Phrenic nerve paresis	17 (3%)
ARDS	9 (1.6%)
Nosocomial pneumopathy	6 (1.1%)
Digestive	8 (1.4%)
Sternal infection	6 (1.1%)

Table 3 Early (10 days) angiographic patency of coronary grafts (ITA Internal thoracic artery)

	No	Patent		Intact	
		No	%	No	%
ITA grafts	386	378	97.9	369	95.6
Left pedicled ITAs	187	184	98.4	178	95.2
Right pedicled ITAs	148	145	98	143	96.6
Free ITAs	51	49	96	48	94.1
Saphenous	60	58	96	58	96

Table 4 Mid term (22 months) angiographic patency of coronary grafts

	No	Patent		Intact	
		No	%	No	%
ITA grafts	208	198	95.2	189	91
Left pedicled ITAs	98	92	93.9	90	91.8
Right pedicled ITAs	80	78	97.5	72	90
Free ITAs	30	28	93.3	27	90

18 h. The mean 24 h thoracic bleeding was 797 ± 895 ml. Sternal complications occurred in six patients (1.1%). No sternal complications were observed among diabetic patients.

Hospital mortality

Nine patients (1.6%) died during their hospital stay (<30 days), two of them of a cardiac cause. These two patients were reoperated for early hemodynamic deterioration, a consequence of myocardial ischemia which was probably ITA-related. Additional saphenous vein bypasses were constructed into the corresponding areas. The myocardium did not recover sufficiently in either case, despite prolonged circulatory assistance. The others causes of early death were multi-organ failure (3), stroke (1), rupture of abdominal aortic aneurysm (1) and acute respiratory distress syndrome (2).

Early graft patency

Among the surviving patients, 193 consented to a repeat catheterization at 10 days after the operation. The angiographic patency rates of the ITA grafts and of the saphenous grafts are illustrated in Table 3. The average early patency rate of ITA grafts was 97.9%. Nine patients had significant stenosis of patent ITA grafts. Three of them were successfully dilated. *With a mean follow-up of 2 years, these three patients were asymptomatic with negative stress tests.*

Follow-up

Follow-up data were collected for 540 of 551 patients discharged from the hospital. Eleven patients (2%) were lost to follow-up in the series. The follow-up period ranged 3–98 months with a mean of 29 ± 20 months. Fourteen patients (2.6%) died late, four of them of a cardiac cause (two had preoperative ejection fractions of less than 30%). The others causes of death were renal failure (1), multi-organ failure (2), lung cancer (3) and unknown (4). Late cardiac events were documented in 27 survivors. Myocardial infarction was reported in four patients, reoperation was performed in two patients (1 for acute aortic dissection and 1 for left ITA anastomosis stenosis), a PTCA was performed in 21 patients. At the last follow-up, 489 patients were asymptomatic and in NYHA class I. Of the patients experiencing angina, 35 were in NYHA class II and 16 were in class III. The maximal stress test was abnormal in 47 patients. Among the 526 survivors, 104 consented to a repeat catheterization at an average of 22 months after the operation (3–48 months). The average patency rate of ITA grafts was 95.2% (97.5% for right ITA pedicled grafts and 93.9% for left ITA pedicle grafts, N.S.) (Table 4 and 5). In 21 patients, a PTCA was performed on 24 coronary vessels at a mean follow-up of 22 ± 20 months. The PTCA was performed on the ITA graft (5 patients), on the coronary vessel under a patent ITA graft (6 patients), and on coronary vessels (10 patients).

Discussion

It has been proved that the use of left ITA anastomosed to the LAD results in a better cardiac event-free and reoperation-free survival than the use of saphenous vein as a conduit to the LAD [12, 17]. However, an unsettled controversy persists for the ideal procedure of coronary bypass grafting between the use of only one ITA and the use of bilateral ITAs. In the pioneer results of Cameron [5], the study group with bilateral ITA grafts was too small for statistical analysis. In a retrospective analysis, Fiore [10] showed a survival benefit for patients with double ITAs

Table 5 Mid term (22 months) patency rate related to the target coronary vessels

	Target coronary vessels							
	LAD		CX		RCA		Others	
	Patent	Intact	Patent	Intact	Patent	Intact	Patent	Intact
Left pedicled ITAs	34/36 =94.4%	33/36 =91.7%	47/49 =95.9%	46/49 =93.9%	0	0	11/13	11/13
Right pedicled ITAs	59/61 =96.7%	56/61 =95.1%	7/7 =100%	6/7 =85.7%	9/9 =100%	8/9 =89%	3/3	2/3

among hospital survivors (74% versus 59%) over patients with single ITA. The patients receiving two ITA grafts had also significant freedom from subsequent myocardial infarction (75% versus 59%), recurrent angina pectoris (36% versus 27%) and subsequent total ischemic events (32% versus 18%). In contrast, Berreklouw [4] showed no significant difference after 8 years in the overall survival rates (96% versus 92%), angina-free cardiac survival rates (95% versus 78%), reintervention-free cardiac survival rates (87% versus 88%) and all cardiac event-free survival rates (49% versus 31%) for the bilateral ITAs and left ITA groups, respectively. Recently, Cosgrove [7], in a prospective study of left ITA and bilateral ITAs, demonstrated a significantly better survival rate following bilateral ITA grafting after a 8-year follow-up if the patients were younger than 60 years of age. To achieve such an improvement at long term, one should question at what "price" this can be reached in terms of hospital mortality and morbidity. Few studies proved that both ITAs can be used with similar hospital mortality and morbidity as with the use of only the left ITA [3, 6]. Other studies showed that postoperative complications increase with bilateral ITA grafting and particularly wound complications [15, 16]. To minimize the morbidity and wound complications after bilateral ITA grafting, we mobilized the ITA in its skeletonized state directly from the chest wall.

Although the risk of ITA injury during mobilization may be greater, the skeletonized technique has several advantages [14]. It permits visualization of the entire conduit to assure that no intra-mural hematoma or injury has occurred. It provides superior length of the in situ grafts. In addition, it has been proved that harvesting with a skeletonized technique preserves twice as much sternal blood flow as harvesting the ITA on a wide pedicle [2, 19]. This could be explained by the preservation of non-intercostal sources of collateral flow and by restraint in the use of cauterization. Microscopic analysis of ITA after skeletonized mobilization shows minimal arterial wall damage, identical to other mobilization techniques [18].

Recently, we have modified our choice of the destination of ITA grafts. As for minimizing the risks of ITA injury during reoperation, the right ITA is preferably brought

through the transverse sinus for grafting of the circumflex (CX) and the left ITA is anastomosed to the LAD. However, our strategy is to use the ITAs as in situ grafts as far as possible and to direct them to the most dominant diseased left coronary vessels.

In contrast to Dion [9], we have not been obliged to add a saphenous graft in parallel to an ITA graft whenever an early ITA flow insufficiency was suspected soon after weaning off cardiopulmonary bypass. The absence of so-called "ITA insufficiency syndrome" could be attributed to the effect of the continuous infusion of calcic inhibitor during the perioperative period. However, the ITA insufficiency syndrome could have been involved in the two cardiac hospital deaths. As in other reports, our experience has shown that hospital mortality was not increased with bilateral ITA grafting [9, 11]. Our experience with a hospital mortality rate of 1.6% included a heterogeneous population with stable and instable conditions, with left main coronary artery stenosis (more than 50%) and with left ventricular dysfunction.

Some reports have expressed concern that postoperative complications increase with bilateral ITA grafting [15, 16]. The rate of reexploration for bleeding was low and comparable with that of other reports. The incidence of perioperative myocardial infarction is consistent with the incidences reported in other series [9, 11]. Bilateral ITA grafting prolonged the postoperative time of assisted ventilation compared to single ITA grafting (median values 18 h versus 12 h, respectively). However, we observed a low incidence of pulmonary complications as we tried to preserve the pleura during the harvesting of the ITAs. In contrast to many other reports linking bilateral ITA grafting with an increased incidence of wound infections [15, 16], we reported a very low incidence of wound complications (1.1%). No wound complications were observed in diabetics patients, a subgroup that has consistently been identified as having an increased risk of infection with bilateral ITA use. As other reports with low incidences of wound complications [8, 11], we used the mobilization of the ITAs as skeletonized arteries. These results suggest that this technical approach could result in less retrosternal soft tissue injury and in preservation of the sternal blood flow.

The early ITA graft patency (97.9%) observed with the skeletonized technique is identical to that of other techniques of ITA harvesting [13]. However, the closer the dissection of the ITA, the higher the likelihood of injury to the ITA, thereby making skeletonization probably the most demanding technique. As for early patency, it has been proved that late patency was not affected by the method with which the ITA was mobilized [13]. The purpose of the study was not to evaluate the long-term results of bilateral ITA grafting, as our follow-up averaged only 31 months (3–88). However our study confirmed the good functional results of bilateral ITA grafting, as reported previously [5, 7, 9–11].

Our experience has demonstrated that bilateral ITA grafting can be accomplished with a low mortality and morbidity. Appropriate selection is important, as certain high-risk patient subgroups have been identified. Patients whose life expectancy may be limited because of advanced age (over 70 years) or poor left ventricular function are generally less than ideal candidates for bilateral ITA grafting. We believe that morbidity, and particularly wound complications, can be minimized by selection of the technique of ITA harvesting. However, the long-term benefit of bilateral ITA grafting suggested by a few studies (7, 10) has to be confirmed.

References

- Accola K, Jones E, Craver J, Weintraub W, Guyton R (1993) Bilateral mammary artery grafting: avoidance of complications with extended use. *Ann Thorac Surg* 56:872–879
- Asai T, Parish MA, Grossi EA (1991) Sternal ischemia is significantly greater with a pedicle IMA compared to a skeletonized IMA. *NY Soc Thorac Surg Proc* 3:6
- Berrekouw E, Schönberger JPAM, Bavinck JH, Verwaal VJ, Koldewijn EL, Van der Linden F, Van der Tweel I, Bredée JJ (1994) Similar hospital morbidity with the use of one or two internal thoracic arteries. *Ann Thorac Surg* 57:1564–1572
- Berrekouw E, Schönberger JPAM, Ercan H, Koldewijn EL, De Bock M, Verwaal VJ, Van der Lindew F, Van der Tweel I, Banninck JH, Bredée JJ (1995) Does it make sense to use two internal thoracic arteries? *Ann Thorac Surg* 59:1456–1463
- Cameron A, Kemp HG, Green GE (1986) Bypass surgery with the internal mammary artery graft: 15-years follow-up. *Circulation [Suppl 3]* 74:30–36
- Cosgrove DM, Lytle BW, Loop FD, Stewart RW, Gill CC, Golding LAR, Goormastic M (1988) Does bilateral internal mammary artery grafting increase surgical risk? *J Thorac Cardiovasc Surg* 95:850–856
- Cosgrove DM, Lytle BW, Hill AC, Taylor PC, Stewart RW, Novoa R, McCarthy PM, Golding LR, Goormastic M, Loop FD (1996) Are two internal thoracic arteries better than one? *J Thorac Cardiovasc Surg* (in press)
- Cunnighan JM, Gharavi MA, Merk FA (1992) Considerations in the skeletonization technique of internal thoracic artery dissection. *Ann Thorac Surg* 54:947–951
- Dion R, Etienne PY, Verhelst R, Khoury G, Rubay J, Bettendorff Ph, Hanet C, Wyns W (1993) Bilateral mammary grafting. Clinical, functional and angiographic assessment in 400 consecutive patients. *Eur J Cardiothorac Surg* 7:287–294
- Fiore AC, Naunheim KS, Dean Ph, Kaiser GC, Pennington DG, Willman VL, McBride LR, Barner HB (1990) Results of internal thoracic artery grafting over 15 years: single versus double grafts. *Ann Thorac Surg* 49:202–209
- Galbut DL, Traad EA, Dorman MJ, Dewitt PL, Larsen PB, Kurlansky PA, Button JH, Ally JM, Gentsch TO (1990) Seventeen-year experience with bilateral internal mammary artery grafts. *Ann Thorac Surg* 49:195–201
- Grondin CM, Campeau L, Lesperance J, Enjalbert M, Bourassa M (1984) Comparison of late changes in internal mammary artery and saphenous vein grafts in two consecutive series of patients 10 years after operation. *Circulation* 70:1208–1213
- Huddleston CB, Stoney WS, Alford WC Jr, Burns GR, Glassford DM Jr, Lea IV JW, Petracek MR, Thomas CS Jr (1986) Internal mammary artery grafts: technical factors influencing patency. *Am Thorac Surg* 42:543–549
- Keeley SB (1987) The skeletonized internal mammary artery. *Ann Thorac Surg* 44:324–325
- Kouchoukos NT, Wareing TH, Murphy SF, Pelate C, Marshall WG Jr (1990) Risks of bilateral internal mammary artery bypass grafting. *Ann Thorac Surg* 49:210–219
- Lefrak EA (1987) The internal mammary artery bypass graft: praise versus practice. *Tex Heart Inst J* 14:139–143
- Loop FD, Lytle BW, Cosgrove DM (1986) Influence of the internal mammary artery graft on 10-year survival and other cardiac events. *N Engl J Med* 314:1–6
- Noera G, Pensa P, Lodi R, Lamarra M, Biagi B, Guelfi P (1993) Influence of different harvesting techniques on the arterial wall of the internal mammary artery graft: microscopic analysis. *Thorac Cardiovasc Surg* 41:16–20
- Parish MA, Asai T, Grossi EA, Esposito R, Galloway C, Calvin BB, Spencer FC (1992) Bone effects of different techniques of internal mammary artery harvesting on sternal blood flow. *J Thorac Cardiovasc Surg* 104:1303–1307

Discussion

Dr. P. Sergeant (Leuven, Belgium): In your presentation you cite as possible advantages of skeletonizing the internal mammary artery: the sternal revascularization, the length of the mammary artery and the possible use as a jump graft fashion. I am not convinced about these three possible benefits. That the length increases much more by skeletonizing the artery, we understand that the mobility is a little bit better but the lengths will not change very much if you don't put the arteries under pressure. The use of jump grafts, even with pedicled mammary arteries, there are no problems of doing two and three mammary artery anastomoses in exceptional cases.

I am not convinced that this outweighs the risks and the possible problems. You pointed out yourself the time-consuming aspect on the one side.

We know that the mammary artery is sensitive to spasms and to any kind of manipulation. You only have contact with one-third of the circumference of the mammary artery in skeletonizing the three-thirds, and I am sure that there will be more possibility of spasm. And the possible danger is at reoperation. Many of us are confronted daily with reoperations with one patent mammary artery, and we like very much to have the flap covering the mammary artery at the time of the anastomosis and definitely at the dissection.

Can you give us some idea, to end with a very precise question, how many grafts have been damaged during prelavation and is this prelavation done by residents in training or is this only done by a specialist? Thank you.

Dr. Braunberger: As you said, the length of the skeletonized in situ grafts don't change very much, but the mobility is better. As reported in 1990 by Galbut, we noticed that the skeletonized technique provides a little superior length and facilitates appropriate orientation of sequential grafts. In our series, we didn't encounter major problems of spasm as we used a papaverine sponge to prevent this phenomenon and, as the application of papaverine was directly on the adventitia, it may be more efficient.

Among all the ITAs we have used, it was very exceptional not to use the ITA with this technique. The harvesting of skeletonized ITAs could be done by residents but it is true that you have to be trained for it. Concerning reoperation, we have only two cases in our series but we modified our strategy over the time. At the beginning of our experience we used the right in situ ITA on left anterior descending and left ITA on circumflex vessels. Now, we prefer to use right ITA on circumflex vessels, going through the transverse sinus. As others, it seems better for reintervention because right ITA is not under the sternum.

Dr. A. Arbulo (Detroit, Michigan): I just rise to congratulate the authors and, I just want to give you my personal experience with 33 cases of skeletonized internal mammary artery. And these cases were operated upon by myself between 1970 and 1973, when we used to have good ventricles and single or double coronary obstructions. Of these 33 cases, four were bilateral. I follow up these cases, 24 of these cases to the present date, and of these, two were bilateral, and of them, we have a patency rate of 90%. So I think that a long follow-up in these skeletonized arteries is very good. Indeed it takes more time, but we didn't have infections and, in this case, no mortality. Thank you very much.

Dr. R. Dion (Brussels, Belgium): I would like to congratulate the authors on a very nice study and very nice patency rates at midterm. One of the reasons why my friend Olivier Bical went on to skeletonize mammary artery was probably the rate of sternal problems that we reported earlier on – we had up to 5.8% of sternal problems – and I must say that I am still using pedicled mammary arteries and not skeletonized, but it has dramatically decreased since we have used warm body surgery. I don't really understand the reason for that, but we have exactly the same as you, 0.8% of sternal problems, since we have used warm body surgery.

The reason why I keep to pedicled mammary artery is because we are a teach-

ing hospital and the senior assistants are changing every six months, and I am convinced that, if we ask them to take skeletonized mammary artery as Dr. Sergeant says, we will have to do many free mammary artery grafts.

I have two questions. First, have you got an idea of the percentage of what bilateral mammary artery you perform over the total number of coronary patients you operate a year? Is it 50%, 40, 60? And the second question is that I am very much impressed by your patency rate with free mammary grafts. We recently had 127 free mammary grafts and, as you quoted, patency at 6 months and 1 year is about 82%. So my question is, how did you anastomose these free mammary grafts, directly into the aorta or to another bypass? Can you answer that? Thank you very much.

Dr. Braunberger: The patients have bilateral ITA grafting represent 60% of the entire patient population receiving coronary bypass grafts during the reporting interval. On the question concerning free mammary grafts, the proximal anastomoses were usually made directly into the aorta. Occasionally, if the aorta was thick, the proximal anastomosis could be made on the 1st cm of a saphenous graft. However, our good patency rate of free grafts suggested that, with satisfactory proximal anastomoses, the free mammary graft patency rate parallels that of the pedicled graft.

Dr. E. Kolesov (Ukraine): I can join the discussants and the author of this presentation, saying that in our clinic over 30 years we have never used cauterization during the preparation of internal mammary artery grafts. Cauterization is used only to stop bleeding of the peripheral branches on the thoracic wall. And we have also performed complete skeletonization of the arteries in a large number of our patients. In our experience, about a 90% patency rate has been obtained during 20–22 years of postoperative results.

So I think that this presentation gives very much more for this problem and I congratulate the authors.