

A STUDY OF SEQUENTIAL ANASTOMOSES IN AORTOCORONARY BYPASS SURGERY; INTERNAL CONFIGURATIONS BY THE CASTING INJECTION TECHNIQUE

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ABSTRACT

Recently, sequential Aortocoronary (A-C) bypass surgery has been used widely for the revascularization of multiple coronary vessel disease. In this study the internal configurations of anastomosed portions were investigated by casting models and the following results were obtained:

1. In crossed side-to-side anastomoses with longitudinal incisions, the anastomosed area for the incised length was larger than those in other anastomoses procedures.
2. Interrupted sutures consistently produced larger anastomosed area for the incised length than other suture techniques.
3. As for anastomotic stenosis, crossed side-to-side anastomoses with one longitudinal and one transverse incision resulted in the most frequent occurrence of narrowings.

Keywords: A-C bypass, Sequential anastomosis, Casting model, Anastomotic stenosis

INTRODUCTION

The sequential A-C bypass has become a more frequent practice for the revascularization of multiple coronary vessel disease.^{1) 2)} Several studies which investigated the anatomical configurations in order to improve graft patency rate have been reported.^{3) 4)} However, these studies did not quantitatively refer to the anastomosed area and stenosis. The internal configurations of anastomosed portions discernible by casting models, the kinds of graft vessels, vascular anastomotic methods and suture techniques were examined in this study.

EXPERIMENTAL PROCEDURES

Anastomoses of grafts to coronary arteries were constructed with three kinds of graft segments in 80 isolated swine hearts. These grafts were 90 canine common carotid artery segments, 50 external jugular vein segments and 100 human saphenous vein segments.

Crossed side-to-side (CC) anastomosis with longitudinal incisions (diamond-shaped anastomosis), parallel side-to-side (PP) anastomosis with longitudinal incisions (conventional side-to-side anastomosis) and crossed side-to-side (CP) anastomosis with one longitudinal and one transverse incision (conventional crossed anastomosis) were carried out

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Received for Publication June 10, 1983

(Fig. 1). Interrupted, continuous and continuous mattress sutures with 6-0 polypropilene monofilament suture materials (Prolene®) were used for these anastomoses (Table 1).

Casts of the anastomosed grafts were made by injection of epoxy resin (Mercox®) under continuous pressure (150 mmHg) with a hand-held injector. By measuring the casting models, the ratio of anastomosed area (=anastomosed area/cross sectional area of the coronary artery; AAR) and coronary incision rate (=length of the coronary arteriotomy/coronary arterial inner diameter; IR) were calculated. Stenosis by anastomotic procedures was classified into 3 grades and its incidence was investigated.

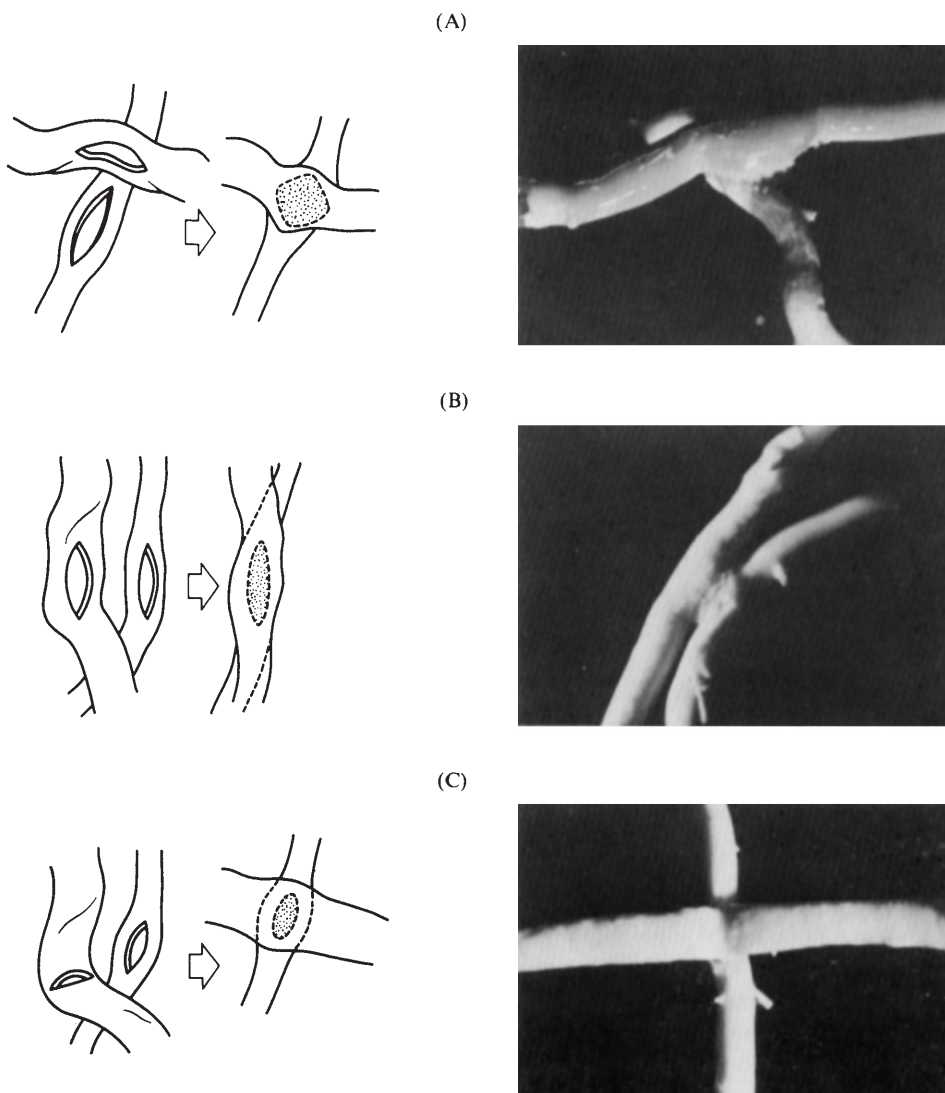


Fig. 1: Anastomotic procedures

A) Crossed side-to-side anastomosis with longitudinal incisions

B) Parallel side-to-side anastomosis with longitudinal incisions

C) Crossed side-to-side anastomosis with one longitudinal and one transverse incision

Table 1. Number of casting models

| Graft | Artery | | | Vein | | | Saphenous vein | | | Total |
|---------------------|--------|----|----|------|----|----|----------------|----|----|-------|
| | CC | PP | CP | CC | PP | CP | CC | PP | CP | |
| Interrupted | 18 | 11 | - | 7 | 7 | - | 14 | 14 | 4 | 75 |
| Continuous | 24 | 10 | 6 | 8 | 7 | 9 | 14 | 14 | 8 | 100 |
| Continuous mattress | 12 | 9 | - | 6 | 6 | - | 14 | 14 | 4 | 65 |
| | | | | | | | | | | 240 |

Legend: CC, Crossed side-to-side anastomosis with longitudinal incisions,
 PP, Parallel side-to-side anastomosis with longitudinal incisions,
 CP, Crossed side-to-side anastomosis with one longitudinal and one transverse incision

RESULTS

It was confirmed that the ratio of anastomosed area (AAR) correlated with the coronary incision rate (IR). The correlation coefficients were $r=0.89$ in the arterial grafts, $r=0.82$ in the saphenous vein grafts and $r=0.73$ in the jugular vein grafts respectively (Fig. 2). The following comparisons among these anastomotic procedures and suture techniques were based on these correlations because it was important in this study that AARs were compared with the same IR. The difference of the graft segments had no effect on these comparisons. When the anastomosed area was larger than the cross sectional area of the coronary artery, the ratio of anastomosed area of CC anastomosis was larger than those of PP anastomosis and CP anastomosis. With regard to the suture techniques, the ratio of anastomosed area was large in the decreasing order of interrupted, continuous and continuous mattress sutures (Fig. 3, Fig. 4).

The incidence of anastomotic stenoses (narrowing frequency rate; NFR) varied according to the graft vessel, decreasing in the order of the jugular vein, saphenous vein and artery (Fig. 5). With regard to the anastomotic procedures, NFR of CP anastomosis was higher than that of PP and CC anastomoses. On the other hand NFR decreased in the order of continuous mattress, continuous and interrupted suture techniques (Fig. 6, Fig. 7).

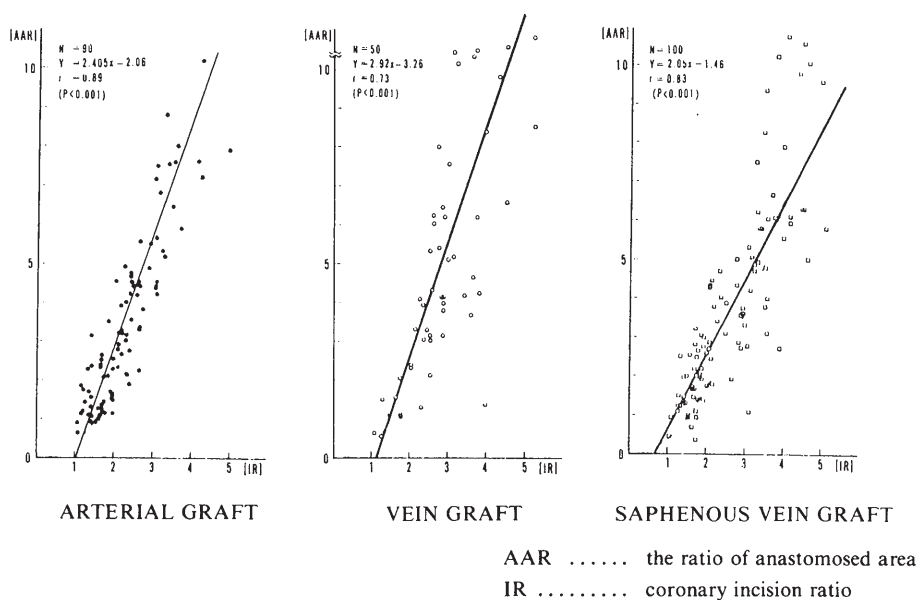


Fig. 2: Correlations between the ratio of anastomosed area (AAR) and coronary incision ratio (IR)

DISCUSSION

Many characteristics regarding sequential A-C bypass procedures as compared with those of multiple individual grafts have been described^{5) 6) 7) 8)}. Some evident advantages of sequential A-C bypass over conventional A-C bypass include a reduction in the number of aortic anastomoses, conservation of graft material and the potential for improved graft patency. On the other hand some of the disadvantages include its technical difficulty and the potential for multiple graft failure due to proximal occlusion. Since only a few experimental investigations regarding sequential A-C bypass have been reported, the present study explored practical anastomotic procedures quantitatively by casting models.^{3) 9)}

The CC anastomoses provided the largest anastomosed area among the three anastomotic procedures. In addition, this procedure was excellent to avoid the appearance of distortion, deformity and anastomotic narrowings. Although PP anastomosis has been the most popular, the anastomosed area for this procedure was smaller than that for the diamond shaped CC anastomoses because of the restricted transectional area. According to the three dimensional structure, CP anastomoses increased anastomotic deformities and narrowings when the length of the graft venotomy exceeded one third of graft's circumference.¹⁰⁾ It was also due to the architectural characteristics of CP anastomoses that the anastomosed area in this procedure was remarkably narrowed. On the other hand, the anastomosed area in interrupted technique was larger than the other techniques in size and the internal projection of the suture line of continuous suture technique seemed to increase turbulence and decrease blood flow due to the purse-string effect.

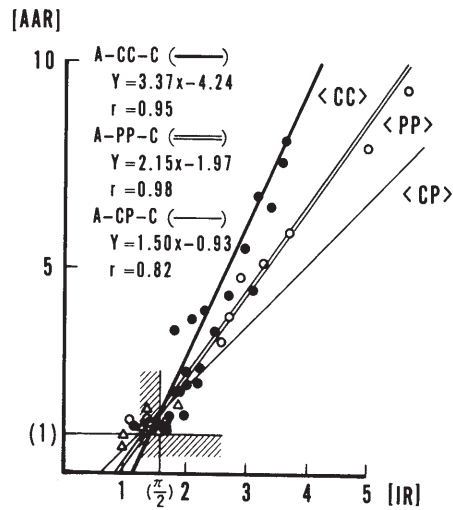


Fig. 3: The ratio of anastomosed area (AAR) for coronary incision ratio (IR) in each anastomotic procedure (Arterial graft, Continuous suture technique)
 Legend: The region where anastomosed area is smaller than cross sectional area of the coronary artery. CC, PP and CP are as previously defined.

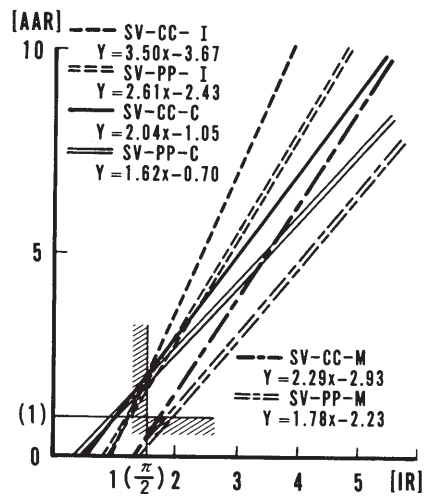


Fig. 4: The ratio of anastomosed area (AAR) for coronary incision ratio (IR) in each suture technique (Saphenous vein graft, Crossed side-to-side anastomosis with longitudinal incisions (CC) and Parallel side-to-side anastomosis with longitudinal incisions (PP))
 Legend: The region where anastomosed area is smaller than cross sectional area of the coronary artery. I, Interrupted suture, C, Continuous suture, M, Continuous mattress suture

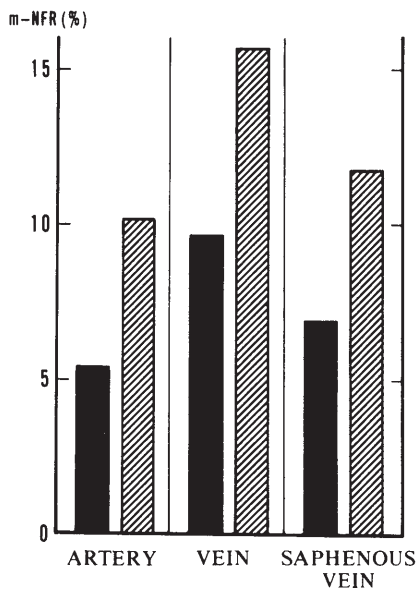


Fig. 5: Incidences of stenosis of graft vessels

Legend: ... Crossed side-to-side anastomosis with longitudinal incisions, ... Parallel side-to-side anastomosis with longitudinal incisions, m-NFR; mean narrowing frequency rate

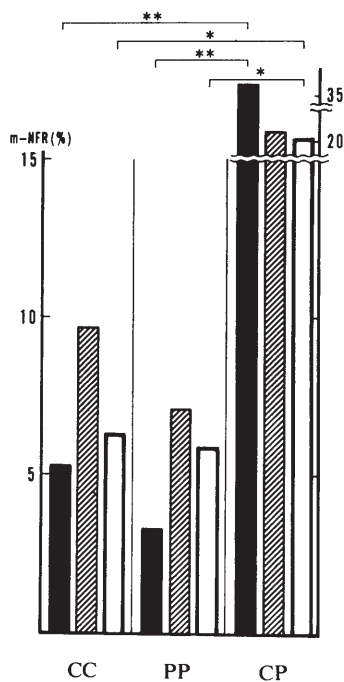


Fig. 6: Incidences of stenosis by anastomotic procedures (continuous suture technique)

Legend: CC, PP and CP are as previously defined.

... Artery Graft, ... Vein graft, ... Saphenous vein graft, m-NFR; mean narrowing frequency rate,

* ... p < 0.05, ** ... p < 0.01

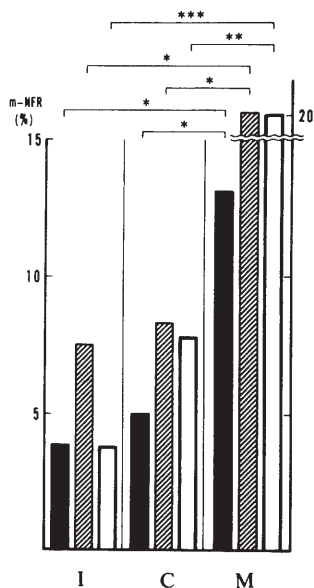


Fig. 7: Incidences of stenosis by suture techniques

Legend: Artery graft, Vein graft, Saphenous vein graft,
m-NFR; mean narrowing frequency rate,

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CONCLUSION

Crossed side-to-side anastomosis with longitudinal incision, using interrupted suture technique was recommended as the most beneficial procedure in sequential A-C bypass surgery.

ACKNOWLEDGEMENTS

The author wishes to thank Prof. Yohtaro Iyomasa and Prof. Syuuichiro Sugimura for their valuable advice and support.

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