

Suture Material as a Factor in the Occurrence of Anastomotic False Aneurysms

An Analysis of 26 Cases

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• False aneurysm formation is a well-recognized late complication of prosthetic graft insertion. Despite the fact that other etiologic factors may be involved, the behavior of the suture material remains of central importance. In a retrospective review of 1,330 peripheral vascular cases, we found 26 cases involving a total of 39 false aneurysms, or an incidence of 2% (26/1,330). Twenty-four of these were directly attributable to failure of the monofilament plastic suture or silk suture material. Braided Dacron suture was used in the original anastomosis in another seven cases, and in these instances the false aneurysms were not related to suture failure but were associated with such factors as previous endarterectomy, failure of arterial wall, and chronic hypertension. None of the 39 aneurysms was secondary to infection or trauma. These results emphasize the importance of using a braided, nonabsorbable suture material to ensure the continued integrity of an anastomosis involving prosthetic grafts.

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Although many etiological factors may be responsible for false aneurysm formation in anastomoses involving prosthetic grafts, we have been particularly interested in the influence of the type of suture material used on the occurrence of anastomotic false aneurysm.

The aim of our study was to determine the incidence and etiology of false aneurysms in relation to suture material employed in vascular anastomoses involving prosthetic grafts in a large series of patients who were followed up as long as 13 years after operation.

PATIENTS AND METHODS

A retrospective review of 1,330 peripheral vascular operations, excluding carotid reconstructions, that were performed by one surgeon (G.C.M.) between 1969 and 1978 was made in respect to anastomotic false aneurysms. There were 26 patients, 21 men and five women, aged 46 to 74 years (mean age, 61 years), who underwent operation for anastomotic false aneurysm, or an incidence of 2% (26/1,330).

Preoperative diagnosis was made clinically in the case of false aneurysms of the femoral anastomoses of aortofemoral bifurcation grafts, and was confirmed by arteriography. In one patient, an aneurysm of the proximal anastomosis of the aortofemoral bifurcation graft was found by arteriography for false aneurysm of the femoral anastomosis. Two false aneurysms of the proximal anastomosis of an aortofemoral bifurcation bypass graft were found on palpation during routine follow-up examinations. One false aneurysm at the proximal end of a tube graft replacement of an abdominal aortic aneurysm was found during arteriography for a thoracoabdominal aneurysm. A false aneurysm at the proximal anastomosis of the tube graft replacement of a descending thoracic aorta was seen on chest roentgenography. Only one patient was symptomatic, with flank pain due to rupture of a false aneurysm at the distal end of an aortorenal bypass graft.

All patients underwent operation for correction of the false aneurysm, and the aneurysm and suture line were carefully inspected to determine etiology on the basis of the exact site of the

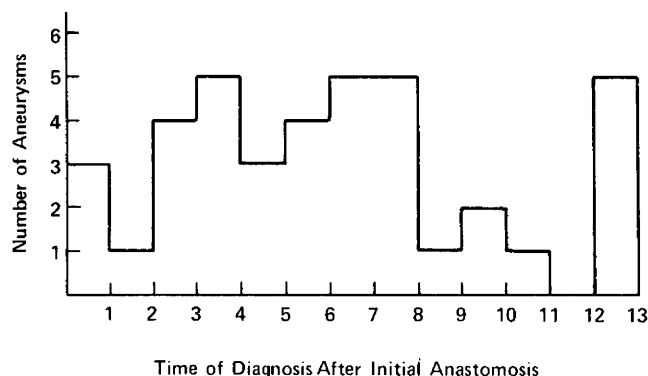
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Anatomic Distribution of False Aneurysms	
Site	No.
Aortofemoral bypass graft	
Proximal anastomosis	3
Distal anastomosis	30
Femoropopliteal bypass	
Proximal anastomosis	1
Distal anastomosis	1
Aortorenal bypass	1
Carotid-subclavian bypass	1
Tube replacement, abdominal aortic aneurysm	1
Tube replacement, descending thoracic aneurysm	1
Total	39



Time elapsed between initial anastomosis and diagnosis of aneurysms (mean, 6.1 years).

aneurysm, suture type, and the integrity of the anastomotic line. Aneurysmal dilation of an artery previously subjected to endarterectomy, suture tears in the graft or artery, and the presence of suture fracture or slack in the suture line were carefully assessed at the time of repair.

RESULTS

The anatomic distribution of the false aneurysms is given in the Table. The femoral anastomosis of an aortofemoral bypass bifurcation graft was the site of 30 of the 39 aneurysms. All of these aortofemoral bypass grafts were of woven Dacron. The proximal anastomosis of a graft replacement for an abdominal-aortic aneurysm was the site in four patients, while four other aneurysms were related to the distal anastomosis of a renal artery bypass, the femoral anastomosis of a femoropopliteal bypass graft, and the distal anastomosis of a femoropopliteal bypass. One other aneurysm was at the proximal anastomosis of a tube graft replacement of an aneurysm of the descending thoracic aorta. Bilateral femoral aneurysms developed in eight patients at some time during the period of review, and in one patient aneurysm formation occurred at the proximal anastomosis and both distal anastomoses of an aortobilateral femoral bypass graft. A femoral aneurysm had recurred after repair in three patients. All of these were related to the breakdown of polyethylene suture.

The time between the initial anastomosis and the diagnosis of false aneurysm is shown in the Figure. The mean time interval was 6.5 years, with a range of two months to 13 years.

The suture materials that had been used were arterial silk (eight aneurysms); braided Dacron (four aneurysms); and polyethylene (27 aneurysms). The average time interval for presentation was similar in all three types.

The anastomoses using arterial silk had been performed in the mid-1950s and represented a relatively small number of cases. Polyethylene suture material was used for a two-year period (1965 to 1967) and was soon abandoned because of early suture failure. Braided Dacron has been used in the majority of peripheral vascular cases since 1967 and was used in the bulk of the 1,330 cases in our study; and the rarity of false aneurysm related to its use is indeed striking.

Suture sizes were similar for different suture types: 3/0 for arterial silk and 4/0 for polyethylene and braided Dacron were used in femoral anastomoses.

In the four cases of anastomotic aneurysms not related to suture failure, the anastomoses had all been originally done with braided Dacron suture. Two of the aneurysms occurred in the same patient. At reoperation, the suture line was intact except for one area where several consecutive sutures had pulled through the wall of a common femoral artery on which endarterectomy had previously been performed. The other two of these aneurysms occurred in moderately hypertensive patients (blood pressure, 160/100 mm Hg), and the findings at operation were the same, with a small localized area of arterial tearing along the suture line.

Excluding those aneurysms occurring subsequent to suture failure, the residual incidence of false aneurysms in this series is 0.3% (4/1,330).

COMMENT

False aneurysm formation at the site of a peripheral vascular anastomosis is a well-recognized late complication of prosthetic graft insertion, with the incidence recently reported as 2%.¹ Early reports² attributed false aneurysm formation to the use of silk suture material for the vascular anastomosis. Even with the advent of monofilament plastic suture materials (polyethylene), however, the type of suture material used continued to be associated with the appearance of anastomotic false aneurysms. Despite the fact that other etiologic factors may be involved, such as the type of prosthetic graft, location of the graft relative to joints, the type of anastomosis formed, degeneration of the native vessel, endarterectomy, chronic hypertension, infection, and the use of postoperative anticoagulants,^{1,3} the behavior of the suture material employed remains of central importance.

Of the various suggested etiologic factors,^{1,3} suture type was the most important contributor to aneurysm formation in this series. Aneurysms following the use of polyethylene suture and arterial silk were commonly related to suture failure. This observation has resulted in the discontinuance of their use in vascular anastomoses.^{1,2} Failure of silk sutures caused by dissolution of the material and ensuing phagocytosis was described many years before the use of silk as a vascular suture.⁴ In those aneurysms that had occurred after an anastomosis with braided Dacron

suture, the anastomotic lines were intact and the defect was found in the native artery or in the woven Dacron graft. The limiting factors of graft integrity and the intrinsic weakness of a diseased arterial wall account for the continued although decreased incidence of anastomotic aneurysm. The incidence of suture failure and knot slippage with braided Dacron suture has been negligible.⁵

Anastomotic aneurysm occurred predominantly in anastomoses with the common femoral artery, more commonly than the frequency of aortofemoral bypass operations (549 cases; 41%) in this series. This was attributed to specific factors relating to this site.^{6,7} Shearing stress on the anastomosis is greater in proximity to a joint, and the femoral artery at this level is often greatly attenuated by disease.

We feel several points in technique are important to minimize anastomotic aneurysms. Anastomoses involving prosthetic graft material should be performed using braided Dacron suture almost exclusively, except where poor quality of the native artery makes the use of a monofilament suture (polypropylene) desirable to minimize suture drag and resultant trauma to the arterial wall. Endarterectomy should be avoided whenever possible.

The anastomosis to the common femoral artery should be placed as high up under the inguinal ligament as practicable. The graft limb is cut at an adequate length to avoid tension and to ensure minimal shearing force at the anastomosis. Sutures should be placed far enough from the graft edge to prevent tearing out secondary to fraying of woven Dacron, which may occur at the oblique cut edge of graft limb.

We feel strongly that braided suture material is indicated in anastomoses involving prosthetic material. These anastomoses require lasting mechanical strength, since tissue growth into the graft material provides insufficient mechanical strength to ensure integrity of the anastomosis. Polyethylene monofilament suture is inadequate because of low mechanical strength and resultant suture failure. Polypropylene monofilament suture has greater mechanical strength than polyethylene, but still may fracture and then unravel from the anastomosis. Similarly, if a suture tears at one site on an anastomotic suture line, the entire suture line may slacken or even unwind due to slippage of the suture. Braided suture, in contrast, is invaded by fibrous tissue⁸ and consequently is locked into position on the anastomotic line. Should a suture break or tear out, slippage and unravelling will not occur, thus ensuring continued anastomotic integrity even in this extreme situation.

If these technical considerations are observed, the strength of the native artery and the suture become the limiting factors in the frequency of late appearance of anastomotic aneurysms. The use of braided Dacron suture material in place of the formerly used polyethylene should reduce the incidence of this complication to minimal levels. Excluding those aneurysms occurring secondary to suture failure, the residual incidence of false aneurysms in our series was 0.3%.

Cases of false aneurysm formation on failure of polypro-

pylene monofilament suture have already been reported by J. D. Rumiseck, MD (personal communication, November 1978). False aneurysm formation secondary to polypropylene suture fracture or slippage may not appear for many years after the original anastomosis. The widespread and inappropriate use of polypropylene suture in recent years for anastomosis between a Dacron prosthesis and a native artery has created a large pool of patients at risk for late false aneurysm formation, and we can reasonably expect an increasing number of case reports of this situation in the next few years.

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Discussion

ROGER F. SMITH, MD, Detroit: I certainly agree with the findings of Dr Starr and his colleagues, and I consider it timely to stress again the important role of suture material integrity in preventing anastomotic false aneurysms, particularly with the recent wide-spread use of the new monofilament polypropylene material for graft anastomoses. Since braided Dacron became available, our group has used this type of suture material exclusively for vascular prosthetic reconstructions.

A few years ago we reviewed our experience with anastomotic aneurysms and found a number of other factors responsible for the development of false aneurysms. Of those factors we considered to be most important in the pathogenesis, mechanical stress accounted for 12%; technical defects, including suture failure, accounted for 15%; noninfective healing complications accounted for 8%; anatomical deficiency—the largest group—accounted for 38%; and hypertension played a major role in 27% of our studied patients. From this analysis, it became apparent that even with the use of an ideal prosthesis and proven suture material, there will continue to be an irreducible incidence of this late complication following vascular reconstructions.

One of the often expressed concerns regarding the development of anastomotic aneurysms is the role of mechanical stress placed upon the common femoral anastomosis in the groin by movements of the hip joint after an aortofemoral bypass operation.

My associate, Dr John Hageman, has recently studied 12 cases of aortofemoral reconstruction to determine if there is any angiographic evidence of distortion or unusual anatomical encroachment at the distal anastomosis when the leg is flexed to 90°.

In one case, we obtained a postoperative translumbar aortogram of the patient 12 months after an aortobifemoral bypass operation. The limb of the graft and the anastomotic site showed no kinking or distortion, as compared with the contralateral side with the leg straight. This was an objective and reassuring observation to us

and lends support to the premise that the groin is an anatomically acceptable site for the distal anastomosis.

L. BEATY PEMBERTON, MD, Kansas City, Mo: The authors of this report may very well be right, but I don't believe they have proved their main point, which is that the braided nonabsorbable suture material prevents false aneurysms while monofilament plastic suture material causes false aneurysms.

Most striking to me is that in their report, the authors state that false aneurysms associated with braided Dacron were all due to other factors, such as endarterectomy, failure of the arterial wall, and chronic hypertension, while the false aneurysms associated with the use of monofilament suture were all due to failure of the suture material. It sounds to me like the good guys and the bad guys. Are you really saying that not one of the false aneurysms associated with monofilament suture had other factors like endarterectomy, failure of the arterial wall, or chronic hypertension as an etiologic basis for the false aneurysm? Is the failure of the suture material the only reason why the false aneurysms occurred with monofilament suture?

My second point is that there is no information about the anastomoses done with each kind of suture material or the dates that they were performed. From the figures given, we have no way of knowing the incidence of false aneurysms in each group. The incidence ratio would give us a much better comparison of the two groups than the absolute numbers that are provided. Does false aneurysm occur so much more commonly with monofilament than with braided Dacron?

Third, might the apparent high incidence of false aneurysm be due to the technical differences in using the two kinds of suture material? Braided Dacron is pulled up tight after each stitch and should be carefully held by an assistant, while monofilament suture slips and does not require such careful holding after each stitch.

In addition, braided Dacron has good knot security with a few throws, while the monofilament suture has poor knot security with many throws and tends to slip, even when it is tied carefully. These technical differences in using the two suture materials have not even been considered as an explanation for the high incidence

of false aneurysms.

My final point is that the suture materials themselves may need some evaluation in terms of size. Does the same size suture of braided Dacron equal the strength of monofilament suture? If the tensile strength of the monofilament suture was much less than the braided Dacron and you used the same size, then the apparent failure of the suture material might simply reflect a difference in the tensile strength, rather than any real difference in the suture material itself.

I learned to do vascular surgery with braided Dacron, and my bias is in favor of the author's point, but I do not think we can discard monofilament vascular suture for prosthetic grafts without answering some of these other questions.

DR MORRIS: In response to Dr Smith, flexion studies are important and hard to do. My thought has always been that if the anastomosis is performed up near the inguinal ligament, the flexion crease will lie below and will not present a problem.

The common femoral artery is the area where statistically we can expect to find the highest incidence of false aneurysms.

Dr Pemberton, all of your questions are valid and well presented, and all are answered in the report. We cannot prove at this time that Dacron is superior to polypropylene because polypropylene has been available for only a short time. We have seen an increasing incidence of false aneurysms associated with the use of polypropylene suture material in Houston and in other centers, and I predict that, as we have seen with the use of other monofilament suture material, the incidence of these aneurysms will increase. That is, surgeons who use polypropylene in the groin are putting patients at risk for the duration of their lifetimes.

I am not a purist, and I do use polypropylene for very difficult renal anastomoses or other technically challenging operations; but in the groin it is not necessary, and its use will provide patients with an unnecessary future risk.

The incidence of our use of polyethylene was very small—it was used only for a period of 18 months in the late 1950s and early 1960s. Nevertheless, it was these anastomoses that provided us with most of the aneurysms.