



## Introduction of loop sutures in microsurgical telescoping anastomosis

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**SUMMARY.** We have designed a loop suture technique for use in microsurgical telescoping (sleeve) anastomosis to prevent problems from the free floating inserted vessel stump. The patency rate of rat femoral arteries repaired with this technique was 95% and that of interpositional vein grafts, in which both the proximal and distal anastomoses were completed with the same sleeve technique, was 81.0%.

Distortion of the inserted vessel by flow disruption has been one problem of the microsurgical telescoping (sleeve) anastomosis. An elaborate procedure for releasing the proximal and distal clamps has been crucial for a successful microvascular sleeve anastomosis to avoid this distortion, especially when the inserted vessel wall is slack, as in a vein repair or in an interpositional vein graft<sup>1,2</sup>.

While Lauritzen<sup>3</sup> opposed fixing the tip of the inserted vessel in the telescoping technique because the procedure was likely to cause distortion of the vessel, several methods<sup>4-8</sup> based on Meier's technique<sup>9</sup> have been described to fix the tip of the inserted vessel stump in sleeve anastomoses. Pan<sup>10</sup> recently reported a new method of telescoping technique, in which the distal stump was divided once longitudinally and repaired later after fixing the tip of the proximal stump to the distal vessel with one suture. Some of these modifications appear difficult to perform with conventional suture material.

It seemed to us theoretically possible to fix the tip of the inserted vessel without distortion if one could place sutures accurately in relation to the position of the proximal and distal stumps. A microsurgical loop has been used to fix the tip of the inserted vessel, and has been tested in the rat femoral artery model both for arterial repair and autogenous vein grafting.

### Materials and methods

A custom-made loop suture with an 8 cm long, circular 11-0 nylon on a 100 micron needle was manufactured for us at Kono Seisakusho Co., Ltd (Soya 2-11-10, Ichikawa City, Chiba prefecture, 272 Japan). This loop suture was used to fix the tip of the inserted vessel.

#### 1. Arterial repair

Wistar rats weighing about 250 g were anaesthetised with an intraperitoneal injection of sodium pentobarbital (35 mg/kg) and the femoral artery was exposed from beneath the inguinal ligament to the origin of the inferior epigastric artery. Two single clamps were placed at the most proximal and distal parts of the dissected femoral artery followed by division of the

artery. The vessel lumen was cleaned with heparinised physiologic saline (10 units/ml). A double-clamp with frame and cleats was applied to the stumps and the adventitia was removed from the tips of the stumps.

Initially, the loop suture was placed from outside in through the full-thickness wall of the proximal stump (Fig. 1A) but this resulted in squeezing of the stump, so the suture was introduced in the opposite direction, *i.e.* from inside out through the full-thickness wall (Fig. 1B). The patency rate of 20 femoral arteries in a pilot study (10 rats) repaired with two loop sutures thus placed and two to four additional sutures at the edge of the distal stump was 65%.

In view of these results, thereafter the loop suture was placed through the adventitia only of the proximal stump (Fig. 1C). Two loop sutures were placed 180° apart and half the femoral artery diameter away from the edge of the stump to avoid pulling the adventitia so it hung over the edge of the vessel. The needles were

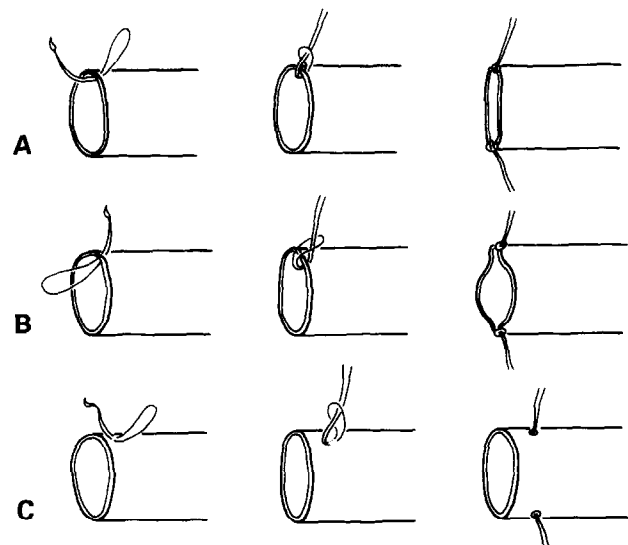


Fig. 1

**Figure 1**—(A) The loop suture introduced from outside in through the full-thickness wall, resulting in squeezing of the stump. (B) Some deformity is found around the loop suture when it is applied from inside out through the full-thickness wall. (C) No stiffness is seen when the loop suture is placed through the adventitia.

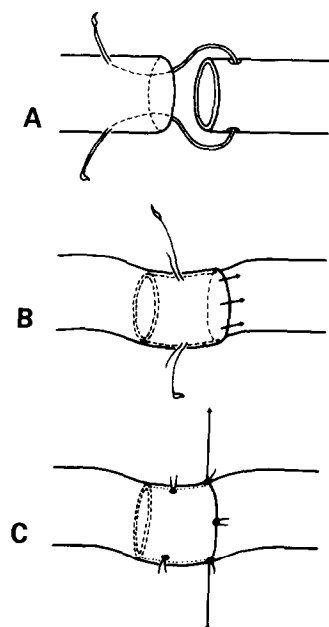


Fig. 2

**Figure 2**—(A) Two loop sutures placed on the proximal stump are passed through the wall of the distal vessel. (B) The two clamps are approximated and the proximal vessel is inserted into the distal one. (C) Four additional sutures are placed 90° apart at the edge of the distal vessel.

then introduced through the wall of the distal stump inside to outside. They were placed 180° apart one diameter of the femoral artery away from the edge of the distal stump with no rotation of the proximal stump (Fig. 2A). Two clamps on the double-clamp

were then approximated and the proximal stump was inserted into the distal stump by a gentle pull on the loop sutures. One side of the loop was divided and the adventitia of the distal vessel near the exit of the loop suture was picked by the needle with the other side of the loop still attached to it. The two ends of the suture were then tied (Fig. 2B). Four additional sutures were placed 90° apart at the edge of the outer vessel through the adventitia of the proximal vessel and through the full-thickness wall of the distal stump, using the cleats on the frame (Fig. 2C). The double-clamp was removed, followed by the two single clamps, which were removed at the same time. Twenty femoral arteries in 10 rats were thus repaired, and observed for patency at 3 weeks postoperatively. Patency of the repaired vessel was confirmed by the empty-refill test distal to the repair site for the femoral artery, and distal to the distal anastomosis for the vein grafting.

## II. Autogenous vein grafting

21 femoral arteries of 19 Wistar rats were exposed as above. A 5 mm long arterial defect was created in the middle of the artery either by simply dividing the artery or resecting a small part of the artery with its deep branch. About 7 mm of the inferior epigastric vein was harvested as a graft.

The proximal anastomosis was completed in the same fashion as the femoral artery repair (Fig. 2A–C), inserting the femoral artery into the graft. The distal anastomosis was similarly performed except that the graft a quarter of the diameter of the femoral artery away from the edge of the graft. The clamps were

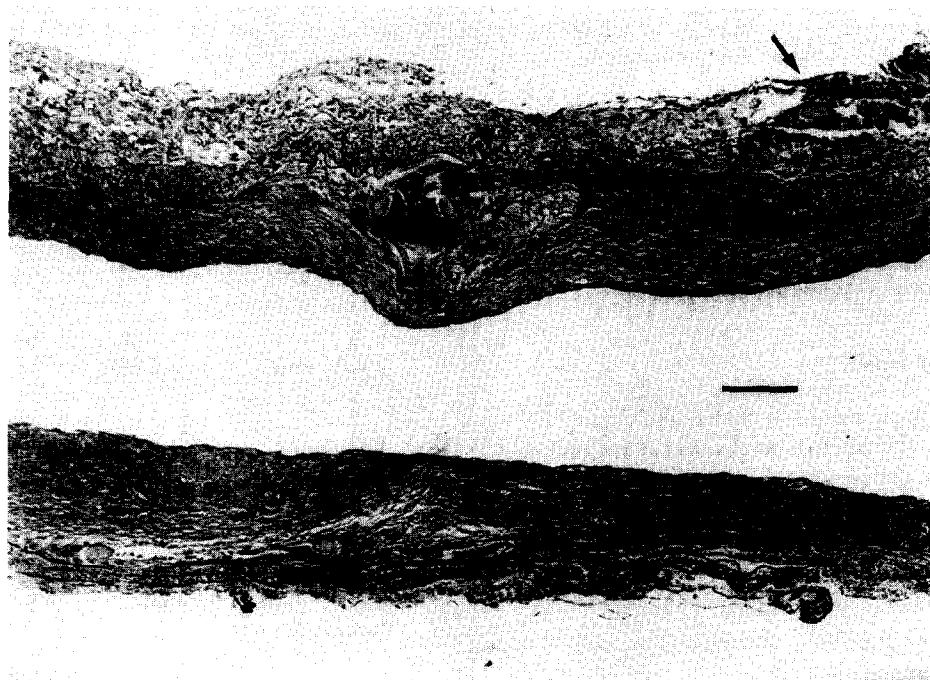


Fig. 3

**Figure 3**—A repaired femoral artery 3 weeks postoperatively. A proximal stump of the femoral artery is inserted into the distal one. The sutures are located both at the edge of the inserted artery and at the edge of the outer vessel (arrows). The inner surface of the repair site is covered with hypertrophied intima (i). Note: The direction of blood flow is from right to left. H & E stain,  $\times 25$  in all photomicrographs. Bar in lumen = 100  $\mu\text{m}$ .

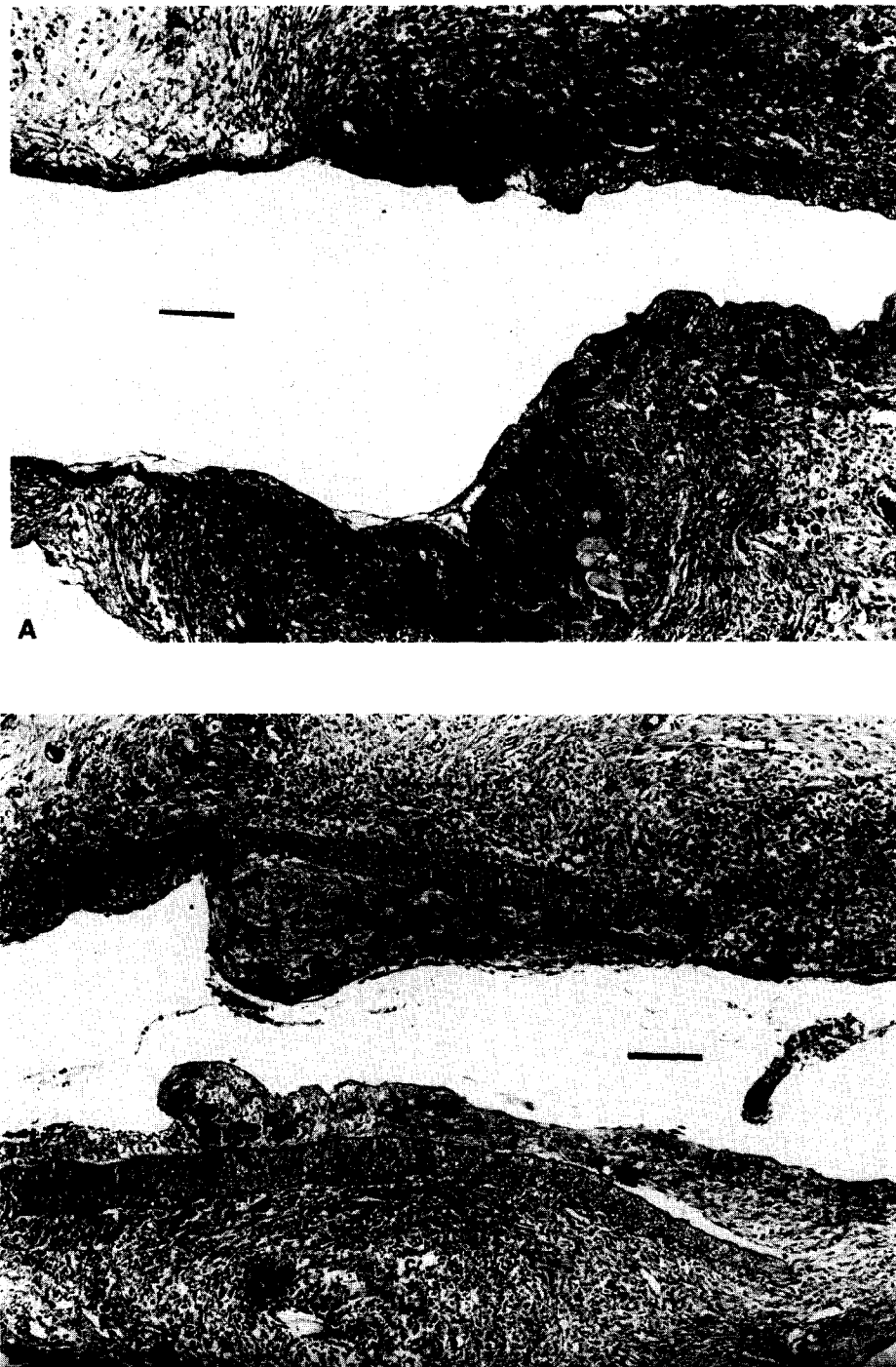


Fig. 4

**Figure 4**—(A) A proximal anastomosis of a vein graft 1 week postoperatively. The femoral artery is inserted into the graft. The thin elastic layer of the graft is interrupted with some bleeding by the loop suture (arrow) put on the femoral artery in the lower half. A profuse cellular infiltration (c) is seen around the anastomosis. (B) Distal anastomosis 1 week postoperatively of the vein graft shown in Figure 4A. The graft is inserted into the femoral artery. The graft wall is still prominent within the lumen.

removed in the same way as for arterial repair. Patency was observed at 1 week postoperatively in three grafts and at three weeks in the remaining 18, and the grafts and anastomosis sites harvested for histology.

### Results

There were two minor difficulties in performing this procedure. One was an entangling of the loop suture because it was too long. The other was difficulty in

introducing the proximal stump into the distal one. This occurred mostly at the proximal anastomosis of a vein graft, probably due to the difference in consistency between the hard wall of the femoral artery and the slack wall of the inferior epigastric vein used as a graft.

Out of 20 femoral artery repairs, 19 (95%) were patent 3 weeks postoperatively. All three vein grafts seen 1 week postoperatively and 14 out of 18 vein grafts examined 3 weeks postoperatively were patent, yielding an overall patency rate of 81.0%.

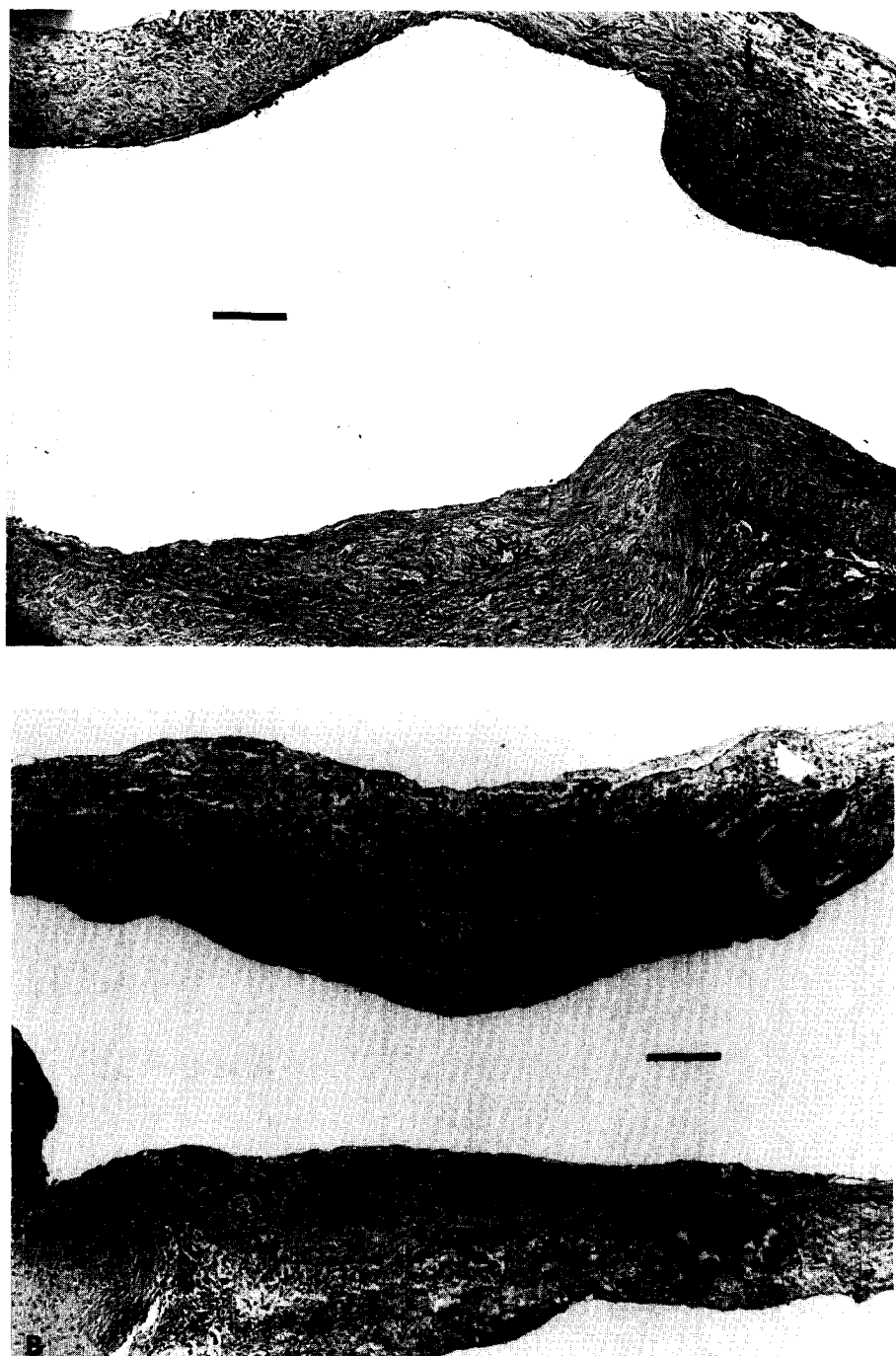


Fig. 5

**Figure 5**—(A) Proximal anastomosis of a vein graft 3 weeks postoperatively. Arrows indicate the end of the inserted femoral artery. Post-stenotic dilatation in the vein graft is seen on the left side. The inner surface of the repair site is covered with intima (i) with some hypertrophy. (B) Distal anastomosis 3 weeks postoperatively of the vein graft shown in Figure 5A. The wall of the graft is pulled into the femoral artery. The thick elastic layer of the artery is interrupted by the loop suture at the tip of the graft (arrows). The inner surface is covered with intima (i).

The cause of failure was not apparent in the failed femoral artery repair because the tip of the inserted vessel could not be seen through the thick wall of the femoral artery, but in two of the failed vein graft cases, the loop suture put on the adventitia of the femoral artery was sufficiently close to the edge of the vessel stump that it had allowed retraction of the stump due to the mobility of the adventitia and deformity of the stump. The cause of failure was not obvious in the

remaining two failed vein grafts, which were patent at least until skin closure.

## II. Histological examinations

Histology of a rat femoral artery 3 weeks postoperatively is shown in Figure 3, and Figures 4A and B represent the proximal and distal anastomoses respectively of a vein graft one week postoperatively,

when a massive cellular infiltration was to be seen around the repair site.

The proximal and distal anastomoses of a vein graft 3 weeks postoperatively are shown in Figure 5A and B respectively. The inflammatory reaction around the anastomosis had subsided and the inner surface at the repair site was covered with intima with some degree of hypertrophy. Post-stenotic dilatation at the proximal anastomosis was more apparent at 3 weeks than 1 week postoperatively.

### Discussion

The patency rate of autogenous vein grafting by the conventional method was 18/20 (90%) and that by the sleeve technique without the loop suture was 17/22 (77.3%) in our previous series of experiments<sup>2</sup>. Statistical analysis showed no significant differences with regard to the patency rate of vein grafting by the conventional method, by the sleeve technique without the loop suture, or by the sleeve technique with the loop suture ( $p > 0.05$ , Chi-square test).

It appears, however, not easy for a right-handed surgeon to perform Meier's or Sugiura's technique with conventional suture material because the needle must be introduced from left to right as well as from right to left. The procedure will be easier by using either a loop suture or a suture with two needles, one on each end. The use of the loop suture allows easier suture placement in a consistent right to left direction. By placement of the loop suture only through the adventitia of the inserted vessel, the stump of the inserted vessel is only loosely fixed to the outer vessel, sufficient to prevent distortion of the inserted vessel and at the same time allowing some mobility so the optimum position can be assumed by the stump after restoring the blood flow.

The loop suture is placed in the adventitia a little away from the edge of the proximal stump to prevent retraction of the invaginated vessel stump due to the mobility of the adventitial tissue. The four peripheral sutures are placed through the adventitia of the proximal vessel a little away from the edge of the distal vessel to minimise tension on the loop sutures.

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