Microvascular patch technique with and without Silastic T-tube bypass

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Poor patency results in the surgery of small vessels operated on between 1959 to 1964 was demonstrated to be in part due to the long period of occlusion of the operated vessel during surgery and the presence of a foreign body (suture) in the lumen of the vessel postoperatively. New suture techniques and T-tube bypass were introduced at that time. New experimental data have not been extensively sought since that time. To provide further current data regarding the above observations, 110 arterial vessels (60 carotid arteries 1.1 to 1.3 mm in outside diameter (OD) and 50 femoral arteries 0.6 to 0.7 mm OD) were operated on in rats to compare the bypass versus non-bypass and vein patch closure techniques. In 1-mm vessels, patency rates 1 month after surgery were 100% regardless of the use of bypass or type of closure. Improved visualization, better suture material, and improved surgical skill were probably chiefly responsible for this success. The success rate was not as encouraging, however, in vessels of 0.6 mm OD.

The following points are brought out: 1) The presence of the bypass causes damage to the intima in 0.6 mm OD vessels and should not be used. Smaller bypasses do not conduct blood well. 2) Bypass is not required in 1-mm vessels as the patency rate is satisfactory and not altered by its use. 3) The major indication for T-tube bypass is in vessels of 1 mm OD and larger, that nourish tissue which would be damaged by vascular occlusion for 20 to 40 minutes. 4) Foreign body (suture) in the lumen is poorly tolerated in 0.6 mm vessels, but can be tolerated more easily in larger vessels. 5) Techniques that limit the amount of suture material in the lumen are indicated in 0.6-mm vessels. 6) After 1 month, suture material has an epithelial covering and if patency has been maintained for that period of time it is likely to remain.

KEY WORDS • microsurgery • vessel suture • bypass surgery • Silastic tube • vascular surgery • T-tube

Microvascular surgery has progressed rapidly during the past 20 years; however, it remains in its infancy as compared to other surgical specialties. Clinical and laboratory research has flourished in the past two decades, but little during this period has been written regarding the use of the microvascular Silastic T-tube or methods of non-constricting closure since Donaghy\(^1\) first described his use of the technique in 1967. It was thought that the T-tube offered the advantages of: 1) an abbreviated occlusion period in procedures where limited interruption of flow through the operated vessel was critical to the postoperative result; 2) the ability to visibly monitor flow both from proximal and distal sources; 3) an injection port for various medications (such as anticoagulant and antispasmodic agents); and 4) both a luminal stent with its short limb and an atraumatic “handle” for rotating and positioning the vessel.

The initial experimental results with the T-tube were marked by low patency rates (as compared to subsequent patency rates).\(^3,6,11\) The size of available surgical materials and the degree of technical expertise necessary for the atraumatic and rapid use of this method were handicaps leading to the early equivocal clinical results.\(^3\) Since these initial laboratory and clinical experiments and impressions obtained during 1960 to 1966, the T-tube has been utilized by some in clinical situations where theoretical advantage would be gained.\(^3,11\) However, few experimental data have existed to support or condemn such usage.

Therefore, the present experimental trial was undertaken to determine: 1) indications for use of the microsurgical Silastic T-tube bypass, if any; 2) restrictions on its use; and 3) the most advantageous method of closure of the longitudinal arteriotomy which is necessary for its insertion.
Carotid Artery Anastomosis

Procedure

The initial experimental design consisted of a sample group of 50 male Sprague-Dawley rats. Each rat was anesthetized with intraperitoneal sodium pentobarbital (5 mg/100 gm), and the right carotid artery, which varied from 1.1 to 1.3 mm in outer diameter (OD), was exposed through a midline neck incision. The carotid artery was dissected free from the vagus nerve and venous arcade for a distance from the division of the internal and external carotid artery to a caudal position as possible without entering the thoracic cavity. Proximal and distal occlusion was obtained by microtourniquet application (KM Hunter and RMP Donaghy, unpublished study). A 3-mm linear arteriotomy was performed to allow insertion of a Silastic T-tube, 0.5 mm in inner diameter (ID) and 0.9 mm in OD. The proximal and distal intraluminal limbs of the T-tube were encircled with 6-0 silk and secured with a surgeon’s knot drawn down to a point where blood would not leak around the tube. This was done with care to avoid constriction of the T-tube lumen or injury to the vessel. The microtourniquets were released. The T-tube was flushed with heparinized saline, and evidence of pulsatile flow was visible through the short limb of the T-tube, documenting restoration of flow in the carotid artery (Fig. 1).

Autologous patch material was harvested from the ipsilateral external jugular vein. The harvested vein was then used to close the arterial opening using one of two suture techniques, with the T-tube remaining in place to provide continual flow past the anastomotic site. The suture techniques utilized were those described by Donaghy in 1967. The first consisted of a simple running over-and-over anastomosis of the vein patch to the lateral margins of the arteriotomy (Fig. 2). This was accomplished by securing the two apices with a simple stitch of 10-0 nylon,* tailoring the patch into an elliptical form approximating the arterial opening, and then suturing the vein patch to the artery in a continuous running fashion. The last two to three stitches were left loose to allow removal of the T-tube at the completion of the procedure.

The second technique was designed to minimize the exposed suture in the vessel lumen (Fig. 3). After similar harvesting of an autologous vascular graft from the external jugular vein, the margin of the longitudinal arteriotomy was sandwiched between the vein patch along its perimeter by using a patch-vein-patch suture technique, performed by first suturing through the patch, then the arterial wall, and then through the patch again. This minimized the exposed suture in the lumen when the suture was tightened. This procedure was continued sequentially along the lateral margins of the arteriotomy with a running technique, again using 10-0 nylon. The final two to three stitches were left loose, as before, to allow removal of the T-tube at the completion of the procedure.

In both techniques, at the completion of the anastomosis the T-tube was removed and the final sutures were tightened. Hemostasis along the anastomotic line was obtained in 1 to 2 minutes with light pressure on a neurosurgical sponge overlying a polyethylene sheet on the patch. Pulsatile flow was documented in all vessels, and the time for anastomosis and occlusion were recorded. The wounds were irrigated with sterile 0.9% NaCl and closed with subcuticular 5-0 Prolene sutures. The rats were allowed to awaken from anesthesia and were returned to individual cages.

Twenty-five rats underwent T-tube placement and vein patching by the conventional over-and-over suture technique, and 25 rats underwent T-tube placement and vein patching by the patch-vein-patch suture technique. Ten rats (five in each suture group) were serially reexplored and sacrificed at each of five time intervals: 24 hours, 48 hours, 1 week, 2 weeks, and 1 month after surgery. The carotid arteries were inspected for patency and condition of the patch, both in vivo and after resection by gross and microscopic methods.

The control group consisted of 10 male Sprague-Dawley rats, five of which underwent simple linear arteriotomy (without insertion of the T-tube) and closure with autologous vein patch employing the over-and-over suture technique, and five of which underwent linear arteriotomy (without insertion of the T-tube) and closure with autologous vein patch using the patch-vein-patch suture technique. Each rat was reexplored at 24 hours, 48 hours, 1 week, 2 weeks, and 1 month after surgery, recording vessel patency and condition of the patch. At the 1-month time period all the rats were

* BV 75-3 needle Ethilon manufactured by Ethicon, Inc., Somerville, New Jersey.
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Fig. 2. Conventional over-and-over suture technique for patch application. A and B: Diagrams showing the method of suture placement and patch position created by this technique. The second diagram of the opened vessel illustrates the degree of intraluminal suture with this technique. C: Photomicrograph of a vessel which had a patch applied by the over-and-over technique. Note the position occupied by the suture and the simple overlapping double layer formed by the patch and the vessel, allowing for significant intraluminal exposure of arterial media and intimal edge. H & E, × 12.

Fig. 3. The patch-vessel-patch suture technique for patch application. A: With this method, unlike the over-and-over technique, there is no intraluminal suture or exposed media caused by the sandwiching of the cut arterial edge by the vein patch. B: Photomicrograph illustrating the patch-vessel-patch technique. At the junction of the patch and the arterial wall there are three distinct layers of tissue: vein patch, arterial vessel, and vein patch, with the suture lying on either side of the sandwich. Note the lack of intraluminal suture or exposed media. H & E, × 30. C: The actual suture technique is shown, with the T-tube in place. At the completion of the anastomosis the T-tube is removed and the sutures are tightened. D: The finished patch and vessel complex.
sacrificed and the vessel was removed for gross and microscopic examination.

Results

Table 1 (Groups 1 through 4) and Fig. 4 outline the experimental results. At postoperative times up to 1 month, patency of the rat carotid arteries 1.1 to 1.3 mm in OD was 100%, regardless of the presence or absence of the T-tube or the technique used to suture the venous patch. Anastomotic time and occlusion time gradually decreased with the increasing number of procedures and refinement of the operative technique; however, the patch-vessel-patch technique on the average was more time-consuming to perform (Group 1: 29 minutes, versus Group 2: 23.5 minutes, \( p < 0.001 \); Group 3: 24.2 minutes, versus Group 4: 22 minutes, \( p < 0.01 \)) than the conventional over-and-over technique. There was no significant difference in occlusion time or in the proportion of the vessel wall occupied by the patch material between the patch suture techniques where equivalent groups were compared. However, if occlusion time was compared between the vessels in which the T-tube was used and those in which it was not (Group 1 versus Group 3, and Group 2 versus Group 4), a highly significant difference was noted (\( p < 0.001 \)).

Grossly, there was a larger amount of exposed suture material in the lumen with the over-and-over technique than with the patch-vessel-patch method. The ratio, however, was seen to decrease with time as the initially exposed suture material was gradually covered, and by 1 month it was extremely rare to see exposed suture material with either technique (Fig. 5).

Microscopically, there was evidence of exposed suture material in both techniques and, in keeping with the gross observations above, there was a much greater amount of exposed suture in the lumen of the vessels undergoing the over-and-over technique when compared to the patch-vessel-patch method. Epithelialization of the exposed suture took place by 1 month, regardless of suture technique. The inflammatory reaction in the vessel wall surrounding the suture material was limited when the suture was entirely within the vascular tissue, irrespective of technique; however, where the suture was either freely exposed in the vessel lumen or surrounded by thrombus, a more obvious lymphocytic and polymorphonuclear leukocytic infiltration was seen in the vascular tissue adjacent to the suture. The intimal surface of these 1.1- to 1.3-mm arteries, except at the point of suture entrance and exit, demonstrated little evidence of injury, regardless of suture technique or the presence or absence of the T-tube.

Femoral Artery Anastomosis

Procedure

In light of the 100% patency results of the above groups, regardless of technique or T-tube application, the experimental model was altered to include the rat femoral vessels (0.6 to 0.7 mm OD). We believed that smaller vessel size and a diminution in flow might be necessary before a significant difference in T-tube application or patch suture technique would be evident.

The first of the experimental groups comprised 10 rats, which, after being anesthetized with sodium pentobarbital (5 mg/100 gm), underwent exposure and

<table>
<thead>
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<th>Group No.</th>
<th>No. of Rats</th>
<th>Vessel</th>
<th>Technique</th>
<th>Vessel Diameter (mm)</th>
<th>T-Tube Size (mm)</th>
<th>Occlusion Time (min)</th>
<th>Anastomotic Time (min)</th>
<th>Percent Patency at:</th>
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<td>1</td>
<td>25</td>
<td>carotid</td>
<td>PVP</td>
<td>1.1–1.3</td>
<td>0.5 ID, 0.9 OD</td>
<td>4.5</td>
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<tr>
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<td>25</td>
<td>carotid</td>
<td>O&amp;O</td>
<td>1.1–1.3</td>
<td>0.5 ID, 0.6 OD</td>
<td>3.7</td>
<td>23.5</td>
<td>100/100/100/100/100</td>
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<tr>
<td>3</td>
<td>5</td>
<td>carotid</td>
<td>PVP</td>
<td>1.1–1.3</td>
<td>—</td>
<td>27.4</td>
<td>24.2</td>
<td>100/100/100/100/100</td>
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<tr>
<td>4</td>
<td>5</td>
<td>carotid</td>
<td>O&amp;O</td>
<td>1.1–1.3</td>
<td>—</td>
<td>25.0</td>
<td>22.0</td>
<td>100/100/100/100/100</td>
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<tr>
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<td>10</td>
<td>femoral</td>
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<td>3.9</td>
<td>27.4</td>
<td>20/15/15/15/15/15</td>
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<td>—</td>
<td>23.2</td>
<td>19.4</td>
<td>27/30/30/30/30/30</td>
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*PVP = patch-vessel-patch; O&O = over-and-over.
† One vessel underwent recanalization.
‡ Three vessels underwent recanalization.

Microscopically, there was evidence of exposed suture material in both techniques and, in keeping with the gross observations above, there was a much greater amount of exposed suture in the lumen of the vessels undergoing the over-and-over technique when compared to the patch-vessel-patch method. Epithelialization of the exposed suture took place by 1 month, regardless of suture technique. The inflammatory reaction in the vessel wall surrounding the suture material was limited when the suture was entirely within the vascular tissue, irrespective of technique; however, where the suture was either freely exposed in the vessel lumen or surrounded by thrombus, a more obvious lymphocytic and polymorphonuclear leukocytic infiltration was seen in the vascular tissue adjacent to the suture. The intimal surface of these 1.1- to 1.3-mm arteries, except at the point of suture entrance and exit, demonstrated little evidence of injury, regardless of suture technique or the presence or absence of the T-tube.
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Isolation of both femoral arteries from the femoral veins, nerves, and soft tissue, under the operative microscope. Vascular occlusion was obtained by use of microtourniquets. Linear arteriotomies were performed on both femoral arteries, and the smallest available T-tube (0.25 mm ID/0.4 mm OD) was inserted and irrigated. The tourniquets were then removed, and pulsatile flow was restored. An autologous vein patch was harvested from each inferior epigastric vein and used for patch material. The vein patch was applied on the right femoral artery using the patch-vessel-patch suture technique and on the left femoral artery using the running over-and-over technique. Patency of the T-tube, despite irrigation with heparinized saline, could not be maintained throughout the entire period of anastomosis, and occasional complete thrombosis of the T-tube necessitated forced irrigation of clot to reopen the tube. Following completion of the anastomosis the T-tubes were removed, the sutures tightened, and hemostasis along the anastomatic line was obtained as above. Times for anastomosis and occlusion were recorded. The wounds were irrigated and closed with subcuticular 6-0 Prolene sutures. These rats were reexplored at 24 hours, and at 48 hours the animals were sacrificed and the vessels removed for gross and microscopic evaluation. Further long-term follow-up study was not undertaken because of the patency rate of 0% at 48 hours.

A control group of 15 rats underwent procedures identical to the above group on each pair of femoral arteries, except no T-tube was inserted. Again the right femoral arteriotomy was repaired with autologous vein using the patch-vessel-patch suture technique, and the left femoral arteriotomy was repaired with autologous vein and the conventional over-and-over technique. All 15 rats were reexplored at 24 hours, and the patency and patch condition were recorded. Ten of the 15 rats were followed for long-term patency and patch condition data. Each was reexplored at 48 hours, 1 week, 2 weeks, and 1 month. At the end of 1 month, the 10

Fig. 4. Upper Left: Early patency at 24 hours. Note the identical patency in both the patch-vessel-patch (PVP) and the over-and-over (O&O) techniques with or without the T-tube in 1.1- to 1.3-mm vessels. In 0.6- to 1.7-mm vessels the overall patency rates are decreased; however, the PVP technique without the use of the T-tube is obviously superior to the other techniques. Upper Right: Late patency at 1 month. These results are similar, except that the late patency in 0.6- to 0.7-mm vessels does not include data for T-tube use, as all of these vessels were occluded at 48 hours. Also, the difference between the PVP and the O&O techniques is amplified because of the higher recanalization rate of the PVP technique. Lower Left: Time for completion of anastomosis. This graph illustrates the added time necessary for both the PVP technique and the insertion of the T-tube. Lower Right: Occlusion time. There is a marked shortening of occlusion time when the T-tube is used in either size of vessels. Here again, the longer anastomotic time necessary for the PVP technique is reflected in the longer occlusion time seen with this technique.
when comparing Groups 5 and 6 to Groups 7 and 8 (use of T-tube versus absence of T-tube), one notes an

**Results**

Results of the second experimental model are seen in Table 1 (Groups 5 to 8) and Fig. 4. With T-tube insertion in 0.6- to 0.7-mm vessels, patency after 48 hours is 0% regardless of the patch suture technique. Anastomotic time was significantly extended \( p < 0.05 \) when comparing the patch-vessel-patch to the over-and-over suture technique. Occlusion time remained much shortened over anastomotic time regardless of suture technique; however, as was noted above, it was much more difficult to maintain continual flow through the smaller T-tube, and complete thrombosis necessitating forced irrigation to clear the lumen was required at least once in all vessels.

Regarding the control group, the patch-vessel-patch technique (Group 7) illustrated an improved early patency rate compared with the over-and-over technique (Group 8) at 24 hours \( p < 0.05 \). This difference widened with time because the patch-vessel-patch technique had a much larger recanalization rate, so that by 1 month patency rates (as measured by the presence or absence of flow through the area of the patch) were 80% for the patch-vessel-patch technique and remained at 30% for the over-and-over technique. As before when there was an increase in the number of procedures performed, both anastomotic and occlusion times decreased; however, both parameters for the patch-vessel-patch technique were significantly longer (anastomotic time: 25.6 minutes versus 23.2 minutes, \( p < 0.01 \); occlusion time: 21.7 minutes versus 19.4 minutes, \( p < 0.001 \)) when compared to the over-and-over technique.

When comparing Groups 5 and 6 to Groups 7 and 8 (use of T-tube versus absence of T-tube), one notes an
obvious improvement in patency in vessels without the T-tube, but a marked lengthening of occlusion time (p < 0.001). Anastomotic time shows no significant difference. The amount of vessel occupied by the patch was approximately equal in the groups without the T-tube; however, the area occupied by the patch when the T-tube was inserted was consistently larger by 3% to 6%. This was probably due to an inability to tailor the patch as well with the T-tube in place, as confirmed by clinical observations of minimal dilatation at the patch site in a small number of the vessels in which the T-tube was inserted.

Microscopically, the 0.6- to 0.7-mm vessels revealed evidence of marked intimal injury in those that had a T-tube inserted (Fig. 6), corresponding to the position of the T-tube, but the site of initiation of the thrombus (whether associated with exposed media or exposed suture) could not be determined. Areas of intimal injury were also evident in the vessels without the T-tube; these were more random and much less extensive than in the previous group. Again, both suture techniques resulted in some exposed suture in the vessel, but the patch-vessel-patch technique obviously less than the over-and-over method, and in the vessels that remained patent the amount of exposed suture was the least regardless of suture technique. Reaction to the suture material was again minimal when the suture was surrounded by tissue, and was more evident when the suture was intraluminal or surrounded by clot.

Discussion

Microsurgery continues to be a developing technique. The cornerstones for microvascular surgery were established early in the 20th century through Alcisc Carrel's pioneering work and discussion of the surgery of small blood vessels published in 1907,1 and the use by Nylen9 and Holmgren7 of the monocular and later the binocular operating microscope in 1921 to 1923 for otological procedures. Over the first part of this century many advances and refinements have been made within these individual techniques; however, the actual union of the two into microvascular surgery as a technique in itself was not described until 1960, when Jacobson and Suarez4 reported on the use of the dissecting binocular microscope for anastomosis of arterial vessels less than 4.0 mm in size. The past two decades have shown the most rapid advances, with marked improvement in microsurgical materials and instrumentation allowing for significant improvement in patency and clinical results.4 Each of these developments advanced microsurgery toward the common goal of producing a permanently patent vessel with restoration of preexisting flow, vessel size, and architecture, thus ensuring the best possible clinical result.

In this regard, we have attempted to document: 1) the niche, if any, for the microvascular T-tube; 2) the best method of repair of a linear arteriotomy in vessels 1.3 mm to 0.6 mm OD (specifically when the T-tube is used or when this technique is necessary in general); and 3) the specific variables that determine the advantages or disadvantages of these methods.

We fail to show any significant difference in results between techniques of suturing an autologous vein patch or use of the T-tube when comparing patency (both long- and short-term) in rat carotid arteries 1.1 to 1.3 mm in OD. These findings were somewhat unexpected, in that previous studies had suggested that patency could be improved with the use of the T-tube, the autologous vein patch to decrease luminal constriction, and the patch-vessel-patch technique to decrease the amount of intravascular foreign material in vessels 0.8 to 0.4 mm in OD.3 The improved patency was thought to be largely due to the above factors; however, in light of the present study other variables such as the use of
hemin irrigation, change in size of the suture material, technical experience gained with serial procedures, and the use of local vascular smooth-muscle relaxants may have also played a role. It may be that the present suture material (10-0 nylon) as compared to the previously used 7-0 and 8-0 silk is much less thrombogenic in the rat carotid system, and therefore the patch-vessel-patch technique, providing the benefit of limiting the amount of suture in the lumen, has no advantage over the conventional over-and-over suture technique in this system. The patch-vessel-patch technique is therefore in all probability not indicated in arterial vessels of 1.1 to 1.3 mm OD with good distal flow, because of the extended anastomotic time and the practice necessary to become proficient at this technique when compared to the conventional over-and-over technique.

The use of the T-tube in this system also appears not to have an advantage regarding patency; however, it does not cause any decrease in patency and does drastically decrease occlusion time. Therefore, use of a 0.5-mm ID/0.9 mm OD T-tube in a vessel 1.1 to 1.3 mm in OD would be indicated in situations where rapid reinstitution of flow or as brief an interruption of flow as possible was advantageous.

In regard to the femoral artery system, one must first decide what factors contributed to the overall poor patency rate despite the technique used. Since vessel patency (regardless of suture technique) at 48 hours after insertion of the 0.25-mm ID/0.4-mm OD T-tube was 0%, the amount of intimal injury caused by this tightly fitting tube must be considered as a common etiologic factor. The exposure of the media was extensive in all vessels in which the T-tube was inserted, coinciding with the position the T-tube had occupied in the femoral artery lumen. A smaller T-tube to test the above premise, even if it could be manufactured in hope of decreasing intimal injury, would be of limited value, for patency of the available T-tube could not be maintained throughout the entire anastomosis despite constant infusion of heparinized saline. Also, it may be that partial obstruction distal to the patch could have occurred from irritation of the clot from the T-tube, forming an area for propagation of an occluding thrombus even with evidence of initial post-anastomotic patency.

In comparing the difference in patency in vessels undergoing autologous vein patching by the patch-vessel-patch or over-and-over suture technique without the insertion of a T-tube, one sees a significant difference in favor of the patch-vessel-patch technique. The only gross and microscopic differences between these techniques found experimentally were a decrease in amount of intraluminal suture and of exposed media by the sandwiching effect of the vein patch by the patch-vessel-patch technique. There was no evidence of vessel narrowing, dilatation, or change in the percent of patch occupying the vessel wall with either technique. It would therefore appear that the patch-vessel-patch technique would be preferred rather than the conventional over-and-over technique in repairing a linear defect in a 0.6- to 0.7-mm arterial vessel, and that the major contributing factors to its superiority are the differences enumerated above.

Recanalization was noted in three of the 15 vessels that underwent patching by the patch-vessel-patch technique in Group 7, whereas there was no evidence of recanalization of any of the 15 vessels that were patched by the over-and-over technique in Group 8. Recanalization in itself probably has little clinical significance in most instances requiring uninterrupted post-anastomotic blood flow for acceptable clinical results; however, the obvious difference in this rate may indicate the presence of other less obvious technical advantages of the patch-vessel-patch technique in 0.6- to 0.7-mm arterial vessels. There are limited data available regarding this interesting observation and therefore its cause cannot be verified; however, one might speculate that the thrombus may have been smaller, less adherent, less organized, or of a different composition than that present in the vessels repaired with the over-and-over technique.

Because of the discrepancies in patency evident above, one must postulate that there are significant differences between the carotid and femoral systems, and that these differences may make the benefits of the patch-vessel-patch and the over-and-over techniques relative to the vascular system as well as to each other. It is interesting to note the apparent increased sensitivity of the femoral system to the difference in technique when compared to the carotid system. Size and flow are less in the former system, apparently accentuating the benefits of limiting the amount of intraluminal foreign body and exposed media provided by the patch-vessel-patch technique. These may be the major and most obvious determinants and it would be convenient to equate these as the only significant variables; however, it must be noted that definitive experimental data characterizing these as the only variables are not available, as there is no information regarding the constancy of one or all of the following: laminar flow, turbulence, \(^{12}\) change in the potential difference across the vessel wall or patch, \(^{10,11}\) shear force, \(^{5}\) or static areas of blood movement created by the patch, \(^{4}\) all of which have been implicated as contributing to small-vessel thrombosis alone and in combination.

**Conclusions**

The following conclusions may be drawn from the data presented above:

1. Use of an appropriately sized T-tube in arterial vessels of 1.1 to 1.3 mm OD: 1) drastically shortens occlusion time; 2) does not alter patency; 3) allows monitoring of blood flow past the anastomosis; 4) provides a port for local injection of medication, such as vasodilator or anticoagulant agents; and 5) provides an intraluminal stent and an atraumatic "handle" with which to move the vessel.
Microvascular surgical techniques

2. Use of a T-tube in 0.6- to 0.7-mm OD vessels is not clinically indicated because: 1) a T-tube is not manufactured small enough to allow insertion into the vessel without causing marked intimal injury, resulting in thrombosis; and 2) continued blood flow cannot be maintained distal to the T-tube despite a constant infusion of heparinized saline.

3. In comparing the patch-vessel-patch and over-and-over suture technique of vascular patch anastomosis: 1) both provide a non-constricting closure of a linear defect in 1.1- to 1.3-mm OD and 0.6- to 0.7-mm OD arterial vessels; 2) there is no difference in patency in 1.1- to 1.3-mm OD arterial vessels, regardless of the technique; 3) there is no apparent indication for the patch-vessel-patch technique in 1.1- to 1.3-mm OD arterial vessels in that it requires a longer anastomotic time and greater microsurgical expertise; 4) there is a significant difference in favor of the patch-vessel-patch technique in 0.6- to 0.7-mm OD arterial vessels in early patency, late patency, and recanalization rate over the conventional over-and-over technique; 5) the etiology of this statistical advantage is experimentally unproven; however, vessel size and flow in the system undoubtedly occupy major roles; and 6) despite the longer anastomotic time and increased skill necessary, the patch-vessel-patch technique should be used to provide a non-constricting repair of linear defects in 0.6- to 0.7-mm OD arterial vessels instead of the conventional over-and-over technique where a patch is employed.

References


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