The cutting-edged microvascular needle
A scanning electron microscopic study

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The authors have compared the vascular endothelial damage caused by blunt-tipped microvascular needles as reported previously with that of sharp cutting-edged needles of comparable size. The same four distinct vascular lesions were found with cutting-edged needles as with the blunt-tipped needles. Even though one experimenter made all of the lesions, and all of the tissue was handled in the same fashion, there was much variation in the extent of the intimal damage. Overall, cutting-edged needles produced slightly less intimal tearing and platelet aggregation than blunt-tipped needles, but the difference was not striking.

KEY WORDS □ microsurgery □ vascular needle □ vascular lesion □ electron microscopy □ vascular suture

In a previous report, we defined the lesions to the vascular endothelium caused during microvascular repair. The lesions described were attributable to the needle and suture material alone. Other variables (such as clip application, removal of loose adventitia, and manipulation of the arterial walls) were eliminated. The needles used in that study were the commonly available tapered blunt-tipped needles. We described four distinct endothelial lesions produced simply by passing the needle through the vessel wall. The lesion types identified were: 1) a large hole in the intima attributed to the actual needle perforation; 2) an intimal tear of variable length continuous with the needle hole but distinguishable from it; 3) a variable number of patches of denuded subendothelium surrounding the needle hole in a satellite arrangement and extending some distance from it; and 4) variable degrees of platelet aggregation and red blood cell adhesion extending from the needle hole over a wide area of the vessel.

It was also noted that the damage produced was significantly greater at the site of entry of the needle into the vessel lumen than at the exit site from the lumen. A theory was offered to explain this finding. We proposed that the luminal compromise secondary to this endothelial damage was not insignificant, and it could be decreased if the microvascular needle had a small cutting edge instead of the tapered blunt tip (Fig. 1). Since the termination of that study, several brands of microvascular needles with a cutting edge have become available. We have therefore repeated the previous experiment, using the cutting-edged needle, to test our hypothesis.

Materials and Methods

The experimental design was identical to that published previously and will be only briefly outlined here. The common carotid artery of the rat was chosen as the experimental model. Thirty Sprague-Dawley rats, weighing 240 to 300 gm each, were anesthetized with intraperitoneal chloral hydrate solution. The animals were then secured in the supine position, and through a midline incision a tracheostomy was performed, exposing both carotid arteries. The operating microscope and microsurgical instruments were used throughout the procedure, assuring that the vessel was handled as little as possible.

The needle was secured with No. 5 jeweler’s forceps and then passed through the vessel, using the complete arc of the needle. A loose tie was placed in the suture after complete passage of the needle through the vessel. Each vessel was used only once in order to avoid dulling of the tip. The blood vessel was never picked up or manipulated, except by the single passage of the needle. The wound was closed in two layers and the animal remained isolated until the time of sacrifice.
A period of 1 to 2 hours elapsed between the placement of the suture and sacrifice of the animal. The animal was reanesthetized and fixation achieved by perfusion with 3% glutaraldehyde solution, buffered in sodium cacodylate with a pH of 7.4 at 38°C via a direct cardiac catheter, as described previously. In 15 animals, a needle was incompletely passed into the opposite carotid artery immediately before fixation, so that the actual passage of the needle could be studied.

The arterial segment was prepared as described previously, and was examined with the scanning electron microscope. Specimens studied consisted of control vessels, blood vessels with suture material in place, and those in which the needle had perforated the vessel and remained in place. The needles studied were all 100-μ needles with cutting edges, and the suture was 10-0 (22-μ) nylon.

Results

The endothelial surface of the vessels from control animals appeared as described for normal rat carotid artery. The precision and adequacy of the tissue preparation was confirmed by this normal appearance and the normal biconcave configuration of the red blood cells in each specimen. As with the blunt-tipped needles, four distinct endothelial lesions were identified. These lesions appeared identical to those created by the blunt-tipped needles reported in the previous study. Also, as with the blunt-tipped needles, the entrance lesion appeared to be more extensive than the exit lesion.

Overall, the size of the hole in the vessel caused by the perforation was one to two times the size of the needle diameter. However, in the majority of specimens it was less than twice the diameter of the needle. This was true if we measured the hole around the suture after the needle was passed completely through the vessel, or if the hole was measured around the needle while it remained in the vessel after an incomplete pass. The extent of intimal tearing continuous with the primary needle hole (Type 2 lesion) was as described for the blunt-tipped needles, but appeared to be less dramatic with the cutting-edged needles. In addition, the satellite areas with denuded intima and the extent of the platelet aggregation, although present, were perhaps slightly less than those seen with the blunt-tipped needles of comparable diameter (Fig. 2). In summary, the cutting-edged needle demonstrated all of the characteristic lesions found with the tapered blunt-tipped needle.
needles, but these lesions were perhaps less dramatic with the cutting edge.

**Discussion**

It is apparent to us that the damage to vascular endothelium caused by the microvascular needle perforation is considerable. The amount of subsequent platelet aggregation and clot formation can be extensive, and these platelets are known to release vasoactive substances that can alter vessel diameter. This could diminish blood flow through a 1- to 2-mm vascular anastomosis expected to give immediate increased flow to an underperfused region of the brain. Obviously then, it is advantageous to use the needle that is most comfortable for the surgeon and causes the least tissue destruction and thrombus formation.

It was our original goal to determine the damage caused to the vessel by the passage of the needle alone. We then hypothesized that adding a cutting edge to the needle would reduce this vascular damage and thus the platelet aggregation and clot formation. To test this hypothesis, one would have to run a comparison of the different needle types and statistically analyze the difference. We could not find a fair and sound way to make this comparison, especially when anticipated differences that would have been easily observable were not present. The damage to the vessel walls varied widely between specimens using the identical size needle. Although most vessels showed a consistent amount of vessel wall damage, some were virtually flawless, while others showed explosive destruction (Fig. 3). A fine ultrastructural study did not seem practical, and its usefulness in this situation was questionable. We therefore were unable to make such a statistical analysis. We did review our material using the blunt-tipped needles and, in an attempt to make a comparison, were able to form some generalizations.

The cutting-edged needle is easier, from the technical point of view, to pass through the vessel wall. Both the blunt and cutting-edged needles produced the identical four vascular lesions, but the extent of these lesions does not appear to be the same. The cutting-edged needle produced less secondary tearing of the intimal surface than the blunt-tipped needles. Also, platelet aggregation and thrombus formation seemed smaller with the cutting edge. These differences, although consistent, were not striking and their significance is uncertain. These findings represent our observation and may reflect personal bias. Since the difference is not dramatic, one must rely on personal preference and comfort when choosing a needle for microvascular anastomosis.

**References**

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