Expanded Polytetrafluoroethylene (PTFE) and External Velour Grafts as Small Artery Substitutes in Dogs

Farouq Samhouri, MD,* Luis H. Toledo-Pereyra, MD, PhD,** Stanley G. Dienst, MD,** and Roger F. Smith, MD***

This experimental study compared the clinical patency, angiographic appearance, and histology of 4 mm polytetrafluoroethylene (PTFE) and external double velour grafts which were used as external iliac artery substitutes in dogs. At one week there were no significant differences. However, at two months, none of the PTFE grafts were open, whereas six of the seven external double velour grafts were patent (p<0.05). Thus, in this study the 4 mm PTFE grafts are poor substitutes for canine iliac replacement.

In spite of the rapid development of arterial substitutes in the past two decades, the problem of arterial vascular replacement for small caliber arteries is still unresolved. There are conflicting reports on the success of polytetrafluoroethylene (PTFE) grafts. Whereas Matsumoto, et al^ reported a 100% patency rate using 3 mm PTFE grafts in the canine femoral artery, Walley, et al^ achieved only a 22% patency rate in a double blind study of PTFE grafts. In addition, while Sauvage, et al^ reported the successful use of 3.5 mm external velour grafts between the ascending aorta and the proximal end of the coronary artery, Harrison^ recently emphasized that synthetic vascular substitutes of less than 5 mm do not remain patent. These conflicting reports prompted us to compare experimentally the clinical patency, angiographic appearance, and histology of PTFE and external velour grafts in dogs.

Materials and Methods

Fourteen healthy mongrel dogs of both sexes, averaging 17 kg in weight, received sodium thiamylal for induction and halothane (0.5-1.5%) for maintenance. Ventilation was carried out through an endotracheal tube. Ringer's lactate (100 ml/hr) was given intravenously during surgery. Through a midline laparotomy incision, the external iliac artery selected for replacement was exposed. Sodium heparin (1500 U) was given intravenously during surgery. Through a midline laparotomy incision, the external iliac artery selected for replacement was exposed. Sodium heparin (1500 U) was given intravenously 10 minutes before the artery was clamped. After a 5 cm long segment of the artery had been excised, it was replaced with the graft chosen for the study, using 6-0 prolene running sutures for the anastomosis. Each vascular graft measured 5 cm in length and 4 mm in diameter and was handled according to the manufacturer's instructions. All grafts were gas sterilized for 3-5 minutes at 270°C, 30 lbs/ sq inch. All anastomoses were performed by the same surgeon in the same anatomic location and with the same preoperative, operative, and postoperative care.

* PTFE grafts were supplied by W.L. Gore and Assoicates, Flagstaff, Arizona. External double velour grafts were supplied by USCI, C. R. Bard, Inc.
Two groups of animals were studied: One group (n=7) received PTFE grafts and the other (n=7) received external velour grafts. Arterial flow was determined before and after graft substitution, as well as before death. After surgery, the follow-up schedule included daily clinical evaluation of the pulse and selective angiography at 1, 3, 4 weeks and 2, 4, 6, and 8 months. The dogs were sacrificed either at the end of the follow-up period or if the angiogram showed that the graft was clotted. At that time, the graft was recovered. All grafts were studied by light microscopy (hematoxilineosin, elastic, and Gomori stains). Statistical analysis included one tailed, paired t-test.

Results

No PTFE grafts were open at two months. Three PTFE grafts were patent at one week, one was patent at three weeks, and one was patent at one month by angiography and by postmortem examination. Six of seven external velour grafts remained open at two months (Figures 1,2). Macroscopic examination of the occluded grafts showed thrombosis formation at the suture lines (Figures 3,4). In open grafts there was some stenosis at the suture lines. No tissue incorporation was observed in the PTFE grafts, whereas some was noted in the external velour grafts.

Discussion

In our study, the one-week patency rates did not differ significantly for either the 4 mm PTFE or external velour grafts. Four of seven PTFE grafts (55%) and six of seven of the external velour grafts (86%) were open at one week. However, at two months, the patency rates were significantly different (p>0.05). Although the numbers are small, none of the PTFE grafts remained open at two months, whereas six of the seven external velour grafts were patent. One external velour graft has remained open for 12 months since it was implanted.

Presently available small diameter synthetic arterial substitutes are still imperfect. Earlier optimistic reports of high patency rates with PTFE grafts led to their wide use in both experimental studies and clinical practice. Matsumoto, et al reported a 100% patency rate using expanded PTFE grafts in dogs with a postoperative follow-up period of 4.5 to 11 months. Similar reports have described the successful use of external velour grafts. Sauvage, et al reported on a knitted dacron, filamentous, 3.5 mm vascular prosthesis used as an interposition graft between the ascending aorta and right coronary artery which, was patent for 16 months postoperatively.

Late patency rates for autogenous vein grafts are currently superior to synthetic vascular prostheses, but they are not always available, nor is the diameter always satisfactory.
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Several factors have been suggested to explain the variability in patency rates. In the past, pore size at the blood-graft interface was implicated, but this factor has been controlled by the manufacturer, and all grafts presently have a low pore size (30 μ). The technique for small vessel surgery does not appear to have been a significant factor in our work since all vascular anastomoses were performed by the same person with the same technique in order to eliminate most technical variables. Other factors, such as anatomic location, length of substitution, and method of follow-up and evaluation, are important in the final assessment of these grafts, but these considerations were not relevant in our study since we have used a standard preparation to assess small arterial substitutes. Furthermore, two different groups of grafts were compared with completely opposite results. We also found that the presence of a femoral pulse is not an accurate way to evaluate graft patency in dogs, since collaterals are rapidly developed. We considered a graft to be open only if its patency was confirmed by angiography or direct demonstration at the time of death.

The results of our study suggest that 4 mm PTFE grafts are not acceptable arterial substitutes for canine iliac replacement. Further work is needed to fully determine the significance of these observations.

Fig. 4

External surface of a 4 mm PTFE graft one month after insertion.

patency rate to antithrombogenicity and high porosity of the grafts, which inhibits the thickening of the neointima of the inner surface.

Wesolowski reported on dacron grafts with a general patency rate of 83% in 48 hours and 36% in 72 hours. He also indicated that patent prostheses recovered at 72 hours demonstrated extremely thin, inner fibrinous layers a few thousandths of an inch thick. However, in Jacobson’s study, arterial prostheses with a 4 mm internal diameter had a 95-98% occlusion rate within 24 hours.

Our study does not support the previously reported data that indicate a high patency rate for PTFE grafts used as small arterial replacements. Our findings agree with those reported by Walley and his associates.
References


