Use of a microvascular coupler for repair of major distal upper extremity artery injuries

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Abstract

Background Non-suturing alternatives to expedite a microanastomoses while still insuring maximum patency rates to date have best been achieved using everting ring-pin devices. Although these so-called couplers have heretofore primarily been used for the venous microanastomosis during free flap transfers, they have also had limited value for their arterial counterpart.

Methods Applications for use of the microanastomotic coupler has been extended to repair solitary arterial injuries in the distal upper extremity. Over the past year, 4 patients specifically with hand or forearm arterial injuries alone, had rapid coupling of the injured vessels.

Results Direct end-to-end repair of all hand or forearm arterial injuries using a microanastomotic coupler was possible in 3 of four cases. Because of the greater extent of injury, the exception required an interposition vein graft; but that too was coupled to each end of the divided artery in end-to-end fashion. In no case was there any compromise of vascular patency.

Conclusion Although hand perfusion in no individual in this series was ever at jeopardy because of persistent collaterals, this demonstration of the efficiency and efficacy of this device may justify future use for critical limb revascularisation.

Keywords Ring-pin anastomotic coupler · Microvascular surgery · Upper extremity artery repair

Introduction

Everting ring-pin devices have become the most successful non-suture method for the performance especially of venous microanastomoses [1–3]. Not only is this a faster, stronger technique; but patency rates are at least equal, with risk of spasm perhaps precluded by the inherent rigidity of the coupler [2, 4]. In contradistinction, their use for arterial anastomoses has been relatively infrequent and sporadic, although Daniel, et al. did use them in the evolution of their absorbable microcoupler as early as 1984 [5]. Except for Nylander, et al. [6] who used the UNILINK system for small artery repair in hand surgery, most series to date have been limited to the arterial anastomosis in free flap transfers [4, 7–11]. Although the thicker wall of an artery makes eversion over the tines of the coupler more difficult, which may often be a deterrent accounting for this underutilization, Spector, et al. [7, 12] have suggested instead more pragmatic limitations that require a hand-sewn anastomosis, such as if lumen discrepancies exceed 1.5:1, arterial lumen caliber is less than 1.5 mm, or obviously if the artery is non-pliable as often the case with atherosclerotic vessels. If these criteria can be met, there is no reason that the ring-pin coupler cannot be used for any arterial anastomosis, as recently proven also acceptable for use for larger artery injuries of the distal upper extremity.

Materials and methods

Within a span of 4 months, 4 patients presented with a traumatic arterial laceration of the forearm or palm (Table 1). Although collateral perfusion to the hand in each case was adequate, a decision was made to avoid ligation and instead repair each artery, as this technique was rapid and the long-term benefit unknown. There was no lumen discrepancy as the divided ends of each artery could be directly approximated to each other, except in one case

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Table 1. Distal upper extremity arterial repairs

Case	Age	Mechanism	Artery	Location	Coupler size (mm)	Complications
JZ	26	Glass	Ulnar	Distal forearm	2.5	None
SR	14	Broken plate	Superficial palmar arch	Mid- palm	2.0	none
DV	19	Glass	Radial	Distal forearm	2.0 × 2	vg required
JM	56	Knife	Radial	Wrist	2.5	none

All repairs end-to-end. v.g. = vein graft

where the beveled nature of the laceration following obligatory debridement resulted in a segmental gap that required an interposition vein graft to avoid tension. All arteries had an outer lumen diameter of at least 2 mm. For all repairs, the GEM Microvascular Anastomotic Coupler System (Synovis Micro Companies Alliance, Inc., Birmingham, Alabama) was utilized. This system has mirror image polyethylene rings with stainless steel pins, with ring sizes varying from 1.0 to 4.0 mm, in 0.5 mm, increments, where the size corresponds to the outer diameter of the vessel that will be approximated.

Technique

After appropriate preparation of both ends of the divided artery, a vessel measuring gauge is used to estimate the outer diameter of the lumen of each, which should be nearly identical in these circumstances. If the artery cannot be approximated without tension, an interposition vein graft will be necessary; and should specifically be chosen to have a caliber exceeding that of the artery so that the coupler size chosen will always correspond to that of the artery so as to maximize its available cross-section for unimpeded flow.

Using a provided winged-jaw assembly that holds both rings independently, one side is held almost perpendicular to usually the most mobile vessel end. A standard curved jeweler's forcep should grasp the vessel without twisting to bring it through the ring opening. The vessel wall is everted and the intima is impaled over the appropriate pin. Spector, et al. [7, 12] use the silicone elastic radio-opaque strip taken from a surgical gauze sponge to push the intima over the pin to minimize intimal trauma, and leave it in place until each successive pin is impaled so as to prevent dislodgement. This is an especially valuable option for the thicker walled artery. The same process is then repeated for the more immobile vessel. Once properly attached without any visible foreign material inside the lumens, the winged-jaw assembly is rotated clockwise until just about to push the coupler off. A final check should insure that the pins are lined up to meet the corresponding hole in its counterpart, while impaling the intima throughout its circumference. A hemostat is used to crimp the 2 wings to further complete the friction fit of

Fig. 1 (a) ends of lacerated ulnar artery in approximation clamp, (b) arterial stumps everted over ring-pins, (c) close-up demonstrates appropriate intima positioning on pins and thickness of vessel wall which can impede proper impalement, (d) completed end-to-end coupled anastomosis, with forceps performing strip test to distal artery, (e) upon release of proximal clamps, filling of distal artery implies patency of artery through coupler

the pins into the holes, which may require more force than customarily needed with a venous anastomosis. With further rotation of the winged-jaw assembly, the coupler and completed anastomosis is released, whose integrity and patency should then be inspected as usually performed.

Results

In 3 patients, a direct end-to-end arterial anastomosis was possible within 5 min following debridement (Fig. 1).

For the fourth patient, a segmental defect of the injured radial artery required a reversed interposition vein graft, conveniently obtained using the adjacent cephalic vein. In this case, two end-to-end artery-to-vein coupled anastomoses were performed (Fig. 2). The lumen caliber of all injured arteries in this series equaled or exceeded 2 mm, with a 2 mm coupler used in 60% of these anastomoses (Table 1). An immediate strip test proximal and distal to each coupler showed unimpeded bidirectional flow. At the last follow-up as appropriate for each patient, an Allen's test was negative, implying maintenance of perfusion via each repaired vessel.

Discussion

Others have previously shown that patency rates and associated risk of thrombosis of coupled arterial versus venous microanastomoses, at least in free flap transfers, is little different [4, 7–11]. This application has assumed that the arteries used were reasonably pliable, there was minimal discrepancy in vessel caliber, and an outer arte-

rial diameter less than 1.5 mm. was avoided [7, 12]. The major advantage of the coupler has been the highly touted speed of the procedure; but also there can be precise intima to intima approximation of the involved vessels, no foreign material such as suture is left in the vessel lumen, and the device itself acts as a rigid external splint to perhaps prevent vasospasm.

Traumatic injury to distal upper extremity arteries admittedly does not mandate repair if adequate hand perfusion persists. However, if the injury is of limited extent such as after a sharp laceration, rapid and precise repair is possible using the GEM Microvascular Anastomotic Coupler System (Synovis Micro Companies Alliance, Inc., Birmingham, Alabama) as shown in this small series of patients accumulated over a brief interval. The direct benefits of this intervention is unknown; but certainly, as this technique has been here applied, demonstrates that larger artery repair is possible with this device, especially if using the newer, very large caliber 'megacouplers (3),' and use in critical limb revascularizations with minimal hesitation would seem to be the next logical step.

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Fig. 2 (a) Beveled laceration of the radial artery, surrounded by vessel loop, (b) cephalic vein graft interposed between debrided ends of radial artery, (c) vein (left) and proximal end of artery (right) impaled on ring-pin device held in winged-jaw assembly, (d) completed repair with dual coupled vein graft to divided ends of radial artery, (e) postoperative perfused hand seen with ulnar artery compression, (f) both radioopaque couplers seen just ulnar to hemaclips at site of cephalic vein harvest.

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