Microvascular Anastomosis of Vessels Less Than 0.5 mm in Diameter: A Supermicrosurgery Training Model in Lagos, Nigeria

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Abstract The development of reconstructive microsurgery has now reached the supermicrosurgery stage. However the anastomosis of vessels under 0.5 mm is still out of the comfort zone of the many microsurgeons. To confirm the technical feasibility and the reliability of this technique We relate our own experience in this regard using the free superficial inferior epigastric flap of the rat as a model for supermicrosurgery training at the Microsurgery Laboratory of the Lagos University teaching hospital. 18 of the 20 free flaps transferred survived at 1 week. Two flaps necrosed and two flaps dehisced. We believe based on our work that the average microsurgeon can become comfortable working with these vessels.

Keywords Supermicrosurgery · Models

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Introduction

Microsurgical techniques have opened up a new possibilities in many aspects of surgery with improved outcome in many others. Though contemporary clinical microsurgery has achieved a high success rates, technical failures still arise [1]. With recent developments, reconstructive surgeons are minimizing donor site morbidity and using only specific tissue required with perforator flap techniques [2]. Many Microsurgeons are increasingly preferring perforator to perforator anastomosis, similarly lymphaticovenular anastomosis is being preferred as the surgical treatment for many forms of lymphedema [3, 4].

But microanastomosis of vessels under 0.5 mm can be quite challenging and most microsurgeons feel uncomfortable with it [5, 6]. The ability to repair vessels of these size gives the contemporary microsurgeon the confidence in performing infantile and pediatric replants and all forms of clinical perforator free flaps [3, 7]. Advances in microsurgery continue to be based on the experimental animal models. The epigastric free flap in dogs was the first reported microsurgical free flap transplantation model [8]. The same model in the rat subsequently became more popular on account ease of care, reproducibility and has been utilized extensively to study flap physiology, microsurgical techniques and transplantation genetics [9, 10]. Having accomplished competency in basic microsurgical techniques, we began experimental work on the free superficial inferior epigastric flap of the rat. We believe this represents an ideal model for anastomosing vessels less than 0.5 mm in diameter and sought to ascertain its technical feasibility and its reliability as a means of developing supermicrosurgical skills.

Fig. 1 0.3 mm SIE artery at x 25 magnification

Methods

We selected 20 healthy male rats of an average weight of 185 g. The aim of the study was to confirm the technical feasibility of superficial inferior epigastric free flap procedure and assess its reliability in the context of our setting. All procedures were carried out by BOM who has considerable experience with experimental microsurgery.

The rat was anaesthetized with 50 mg /kg intraperitoneal ketamine at induction and the same dose is usually repeated at about hourly interval. This was subject to great variability and dosage was titrated with response. We proceeded to shave the entire lower abdomen and groin area. An elliptical skin and fat flap 3 cm by 1 cm (mean flap dimension) with the long axis along the groin crease was designed. The flap was raised based on the superficial epigastric vessels SIEA (0.3 mm–0.4 mm) SIEV (0.6 mm–0.8 mm) which arises from the femoral vessels 1 cm distal to the inguinal ligament. The surrounding branches are coagulated using bipolar diathermy. The vessel was not completely skeletonized to minimize risks of pedicle torsion.

The pedicle was then bathed with 2% lidocaine and covered with a saline soaked gauze and left for 20 min. When the viability of the flap has been ensured the pedicle was divided and the blood was gently squeezed from the flap. The blood was then irrigated from cut ends with

Fig. 2 Patent SIEA following anastomosis

heparinized saline (250 units /ml). The vessel ends were the anastomosed end to end with nylon 11-0 suture (ethicon) on a 75 μ m needle under x 25 magnification (OPMI-1). Four sutures were placed in artery while 6 were placed in the vein on the average.

Warm saline irrigation was done after clamp removal and the anastomosis was left for a period of 20 min. The flap was sutured back with 5/0 nylon and the animal returned to its cage. The wound was inspected on a daily basis for a week and 3 rat groins re-explored after a week.

Results

All animals survived the procedure and were observed for a week. The flaps were inspected for evidence of necrosis daily. No autocannibalisation was observed in any animal. Two of the groin wounds partially dehisced but were viable. Two flaps were found non viable (necrotic by the 3rd post operative day) following transfer. All other flaps survived completely and were healthy at 7 days. Three groins were re-explored at the end of a week and the anastomosis were found to be intact.

Discussion

As reconstructive microsurgery continues to evolve and have widespread implications, supermicrosurgery (anastomosis of vessels less 0.5 mm) has become the next frontier [11]. In this work several technical points which have been useful to us are highlighted.

We have found that topical 2% lidocaine application to the pedicle helps overcome the spasm and confirms flap viability before transfer [12]. Good quality microinstruments makes a difference as the single tip of one half of a vessel dilator is larger than the lumen of a 0.3 mm vessel at rest. As such meticulous care is required in dilating such a vessel.

Magnification with the operating microscope at x 25 was used for this work however we recommend that which ever magnification comfortable for the microsurgeon should be preferred. Meticulous pedicle dissection to minimize spasm and avoid pedicle injury is crucial to having a viable flap.

We tend to use a single 5 mm clamp only on the pedicle side, this we have found is less bulky, takes up less vessel length while anastomosing the vessels and keeps the coloured background as close to the vessel as possible.

Flooding the field with saline constantly against a brightly coloured background makes lumen visualization easy. We do admit that a steep learning curve does exist for this exercise but can easily be acquired by practice as reported by other workers [13]. Our 90% flap viability rate at 1 week confirms the technical viability and reliability of

this procedure. One limitation of this study may be the possible role of neovascularization in flap survival as there were no controls.

While there are several models to teach basic microsurgical techniques, animal models simulate clinical scenarios better than the others. Rat models are inexpensive, reliable, easily available and easy to anaesthetize and care for. There are even fewer models to teach supermicrosurgical skills. The Deep inferior epigastric perforator flap has been described to practice supermicrosurgery techniques but has the drawback of tedious dissection and long operating times [5] (Figs. 1 and 2).

We are of the opinion that the Superficial inferior epigastric flap offers the distinct advantage of a easy dissection, shorter operating times and simplicity in learning supermicrosurgical techniques.

Conclusion

This study further confirms the technical feasibility of the supermicrosurgery and demonstrates its reliability. It is our belief that this is within the capabilities of the average microsurgeon keen on supermicrosurgery work.

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