Hyaluronic Acid Viscoelastic Medium as an Aid for Microsurgical Venous Anastomoses

Ilker Yazici, MD, Gulsah Usta, MD,‡ Ozlem Boybeyi, MD,†*
*Zafer Onaran, MD,‡ and Sevin Fariz, MD**

Abstract: The thin-walled structure of veins leads them to stay collapsed during anastomoses, thereby the incidence of technical failures is more common than arterial anastomoses. In order to overcome this problem, we are introducing the use of viscoelastic material based on our experience on rats. Six rats were used in order to study the technical feasibility of the viscoelastic material during microsurgical vein anastomosis. End-to-end anastomoses were performed on rat jugular veins using 0.5-1 mL of the viscoelastic medium applied to the ends of the veins and surgical field under ×30 operating microscope magnification. Then 1.8% (n:3) and 3.0% (n:3) hyaluronic acid was used as a viscous medium in order to keep the vein lumens open during anastomosis. In conclusion, we have found that 3.0% hyaluronic acid viscoelastic medium facilitates microvenous anastomosis in rat. Studies involving human practice are needed for further evaluation of this technical refinement.

Key Words: Microvascular surgery, vein anastomosis, hyaluronic acid, viscoelastic

(*J Craniofac Surg* 2013;24: 585–586)

Microvascular venous anastomoses are among the most challenging steps of microvascular head and neck area reconstruction. The thin-walled structure of veins renders them more challenging to anastomose. Accidental through sutures which include back wall or many other technical errors lead to venous obstruction and eventually flap necrosis. The thin-walled structure of veins leads them to stay collapsed during anastomoses, thereby the incidence of these technical failures are more common than arterial anastomoses. In order to overcome this problem, we are introducing the use of viscoelastic material based on our experience on rats.

Six rats were used in order to study the technical feasibility of viscoelastic during microsurgical vein anastomosis. All surgeries were performed by using aseptic technique and under surgical microscope magnification (×30) (Amscope, China). After induction of general anesthesia using ketamine (50 mg/kg) subcutaneously, and incision starting from the left neck to the thorax was performed. After microdissection, left jugular veins were found just lying on the clavicle (Fig. 2A). Next, the vein was dissected free from the surrounding connective tissue, and microvascular clamps were applied to the vein and the vein was divided. After washing the vein lumens, approximately 0.5–1 mL of 3.0% (3 rats) and 1.8% (3 rats) hyaluronic acid viscoelastic medium (Protectalon; VSY Biotechnology, Istanbul, Turkey) was applied to the surgical field starting from the lumen of the vein edges without leaving any bubbles (Figs. 1A–C). Then anastomosis was performed by inserting interrupted sutures of 10.0 Ethilon (Ethicon, Ireland) (Figs. 1D–F). Before putting the last suture, the viscoelastic medium was milked out of the vein and flushed with heparinized saline. After 2 weeks of follow-up, none of the animals showed any neurological defect or systemic illness and the anastomoses were found patent. We have used 3 rats for each 1.8% and 3.0% hyaluronic acid concentrations. We have found that 1.8% concentration was better for easy removal from the anastomotic side after the anastomosis when compared to 3.0%. The 3.0% concentration remains in the lumen after anastomosis for about 5 minutes (can be observed from outside) (Fig. 2B) without interrupting anastomosis and anastomosis stays patent at second week control, and no systemic embolus signs were observed in any of the 6 rats. On the other hand, 1.8% concentration cannot provide adequate mechanical properties and will slowly ooze away from the site because of its lower viscosity. As a result, we have found that 3.0%

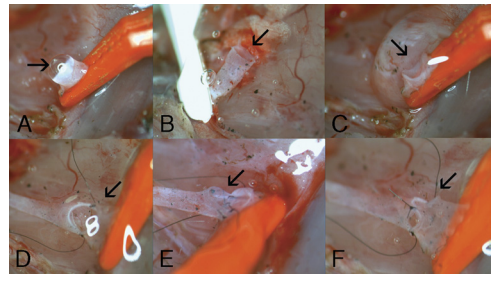

FIGURE 1. The sequential photographs of rat jugular vein using 3.0% Protectalon (VSY Biotechnology) under operating microscope magnification of ×30. Please note that the arrows are pointing to the aperture of the vein ends. A, The viscoelastic medium applied to the distal end of the vessel enough for rendering the lumen open. B, The area flooded with viscoelastic material creating a medium for anastomosis (proximal end). C, The area flooded with viscoelastic material creating a medium for anastomosis (distal end). D, First 2 sutures inserted and the lumen stays open by itself. E, Posterior wall anastomosis finished and the lumen stays open without any need for manipulation. F, Easy suture placement is possible without any manipulation or assistance to open the vessel lumen.

From the *Plastic Reconstructive and Aesthetic Surgery Department,†Pediatric Surgery Department, and ‡Ophthalmology Department, Kirikkale University School of Medicine, Kirikkale, Turkey.
Received August 30, 2012.
Accepted for publication November 4, 2012.
Address correspondence and reprint requests to Ilker Yazici, MD, Kirikkale Universitesi Plastik Cerrahi AD, Saglik sok. Fabrikalar Mah. 71100, Kirikkale, Turkey; E-mail: ilkeryazici@gmail.com
The authors report no conflicts of interest.

ISSN: 1049-2275
DOI: 10.1097/SCS.0b013e31827c828f

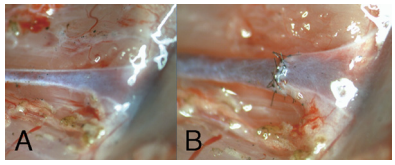

FIGURE 2. A, B, The photos of the jugular vein before and after anastomosis using 3.0% viscoelastic medium. Please note that the vein seems patent and no visible thrombi or hyaluronic acid remnant was observed 20 minutes after anastomosis.

viscoelastic medium provides mechanical properties which facilitates vein anastomosis. The viscosity and mechanical properties also depend on the crosslinking and biochemical properties. Percentage for some preparations may have different efficacy biomechanically.

Viscoelastic materials mostly including variable concentrations of a naturally occurring polysaccharide hyaluronic acid have been used extensively in order to facilitate ophthalmologic surgery.[1] During ophthalmologic surgery, interventions especially for anterior chamber viscoelastic materials provide many advantages including (1) clear transparent medium, which prevents dessication of delicate tissues enabling surgical instruments to work in the medium; (2) viscoelastic properties close to human soft tissue, which enable delicate structures to stay originally where they stay by its hydrostatic pressures and weight; (3) optical properties much concordant with microscope magnification, preventing light reflections from the surgical field to the surface of the material; (4) prevention of oozing of blood or fluids by its hydrostatic pressure; and (5) biocompatibility.

Vascular usage of hyaluronic acid has many advantages as implants or prostheses covered with hyaluronic acid and/or including it in fibrin glues.[2–4] Microvascular usage of hyaluronic acid was also found feasible.[5,6] These results are depending on many biological capabilities of hyaluronic acid, including antithrombotic activity and regulatory effects on cellular structures including endthotelium.[2,4] Intravascular use of hyaluronic acid due to its viscoelastic properties was first reported and compared to conventional techniques by Arnbjörnsson.[7] Arnbjörnsson have used hyaluronic acid on rat femoral artery anastomosis and could not find any difference between conventional techniques. We believe that intra-arterial usage of hyaluronic acid may lead to an embolus to end arterial circulation and lead to necrosis. This was well documented in cosmetic surgery literature originating from cosmetic filler injections.[8,9] According to our study, we have found that usage of hyaluronic acid viscoelastic facilitates microsurgical venous anastomosis especially for thin-walled and large veins by providing such advantages: (1) the vein lumen stays open from the beginning to the end of anastomosis including visualization of all wall structures including adventitia; (2) it prevents blood oozing and/or pooling around the anastomotic area, thus preventing fibrin and thrombus formation; (3) it prevents delicate tissues to dry; (4) it keeps the ends of suture ready for forceps gasp by preventing the suture end to stick on itself or on the vessel wall; and (5) it keeps the tips of the instruments free of blood cloth or debris.

In conclusion, we have found that 3.0% hyaluronic acid viscoelastic medium facilitates microvenous anastomosis in rat. Hyaluronic acid viscoelastic medium is a cheap and feasible option for the favor of microsurgical venous anastomoses. Studies involving human practice are needed for further evaluation of this technical refinement.

REFERENCES

1. Goa KL, Benfield P. Hyaluronic acid. A review of its pharmacology and use as a surgical aid in ophthalmology, and its therapeutic potential in joint disease and wound healing. *Drugs* 1994;47:536–566
2. Pandis L, Zavan B, Bassetto F, et al. Hyaluronic acid biodegradable material for reconstruction of vascular wall: a preliminary study in rats. *Microsurgery* 2011;31:138–145
3. Pandis L, Zavan B, Abatangelo G, et al. Hyaluronan-based scaffold for in vivo regeneration of the rat vena cava: preliminary results in an animal model. *J Biomed Mater Res A* 2010;93:1289–1296
4. Gunaydin S, McCusker K, Sari T, et al. Clinical performance and biocompatibility of hyaluronan-based heparin-bonded extracorporeal circuits in different risk cohorts. *Interact Cardiovasc Thorac Surg* 2010; 10:371–376
5. Lepidi S, Grego F, Vindigni V, et al. Hyaluronan biodegradable scaffold for small-caliber artery grafting: preliminary results in an animal model. *Eur J Vasc Endovasc Surg* 2006;32:411–417
6. Wadström J, Wik O. Fibrin glue (Tisseel) added with sodium hyaluronate in microvascular anastomosing. *Scand J Plast Reconstr Surg Hand Surg* 1993;27:257–261
7. Arnbjörnsson EO. Sodium hyaluronate as an aid in microvascular surgery. *Microsurgery* 1986;7:166–167
8. Kassir R, Kolluru A, Kassir M. Extensive necrosis after injection of hyaluronic acid filler: case report and review of the literature. *J Cosmet Dermatol* 2011;10:224–231
9. Kim DW, Yoon ES, Ji YH, et al. Vascular complications of hyaluronic acid fillers and the role of hyaluronidase in management. *J Plast Reconstr Aesthet Surg* 2011;64:1590–1595