

*Technical Note*

Microvascular Anastomosis Using Only 2-Throw Reef-Knots: A Technical Note

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This study has been presented as a platform presentation at the 17th Annual Conference of Cerebrovascular Society of India between 16 and 17 September 2017 at New Delhi, India.**Corresponding author:** Nupur PRUTHI ✉ pruthi_nupur@yahoo.co.inTo watch the surgical videoclip, please visit
<http://turkishneurosurgery.org.tr/images/22636-video-1.mp4>
<http://turkishneurosurgery.org.tr/images/22636-video-2.mp4>**ABSTRACT**

In macrosurgery creating a knot with at least three throws is an established practice. The potential disadvantages of this practice in microsurgery include the following: the direction of the cut ends interfere with the suture line, unbalanced nature of knot disturbs the apposition of delicate vessel ends and the excessive knot weight. A reef knot with only 2 throws may thus be a better alternative. We have described our technique of end to end anastomosis with 2-throw reef knots in a rat femoral artery model using one way up method. Judging from the surgical outcome the practice of two throw reef knot seems feasible and appealing.

KEYWORDS: Throws, Reef knot, Microvascular anastomosis**■ INTRODUCTION**

In conventional microsurgery, a knot formation with 3 throws is generally advised (1,6). Macrosurgery literature sufficiently evidences that, for security, a knot should be formed with 3 or more throws (2-5). Conversely, microsurgery literature lacks any such evidence supporting the conventional practice of making 3 throws for a knot.

Knotting with 3 throws has a few potential disadvantages. For instance, the cut ends of a 3-throw knot do not lie perpendicular to the suture line. As a result, the cut ends may interfere with the placement of the adjacent suture (Figure 1A, B). Therefore we believe that the third throw forms an unbalanced knot, which causes the cut ends to be angulated. It may disturb the apposition of the vessel ends. In addition the third throw also adds to the weight of the knot. These technical issues of 3-throw knot may not be of much significance in macrosurgery. However, in microsurgery,

where the vessel diameter is <1mm, the distance between adjacent sutures is extremely less, wherein the vessel walls are extremely thin to bear the excessive knot weight, leaving open the high possibilities of the cut ends getting entangled in the adventitial tissue and knot distortion; these potentially negative effects of third throw cannot be neglected (Figure 2A, B). Conversely, a reef knot with 2 throws is balanced.

The microsurgery literature lacks evidence on the superiority of a 3-throw knot over 2-throw knot. We have described here our technique of end-to-end anastomosis with 2-throw reef knots in a rat femoral artery model using one-way up method.

■ TECHNIQUE

Sprague Dawley rats (age: 3-4 months, weight 250-400 g) were obtained from the Central Animal Research Facility of the Institute. All experiments were performed with the approval of the Institutional Animal Ethics Committee.

Technique of inverted reef knot: First, the short end of the thread will be on the left hand side (for a right handed surgeon). Holding the long end of the thread with the left hand, the instrument in the right hand is placed on the near side (toward the surgeon) of the long end thread. A loop is subsequently made, the short end is grasped by the instrument in the right hand and crossed to the opposite side. The short end now lies on the right hand side. The long end of the thread is continuously held in the left hand. The instrument in the right hand is now placed on the far side (away from the surgeon) of the long end of the thread. A loop is subsequently made, the short end grasped by the instrument in right hand and crossed to the opposite side (Video 1).

Technique of regular reef knot: First, the short end of the thread is on the right hand side (for a right handed surgeon). Holding the long end of the thread with the left hand, the instrument in the right hand is placed on the far side (away from the surgeon) of the long end thread. A loop is subsequently made, the short end grasped by the instrument in the right hand and crossed to the opposite side. The short end now lies on the left hand side. The long end of the thread is continuously held on the left hand. The instrument in the right hand is now placed on the near side (toward the surgeon) of the long end of the thread. A loop is subsequently made, the short end grasped by the instrument in the right hand and crossed to the opposite side (Video 2).

Anastomosis procedure: Under general anesthesia and aseptic conditions right groin incision was made. Femoral artery was mobilized. Vasospasm was relieved with 1% lidocaine. The vessel clamp was applied and the artery was divided. A background was placed underneath the vessel ends to obtain a better contrast. Then adventitial preparation was done. The first suture was placed as far away from the surgeon as possible (Figure 3A). The next few sutures, 2-4, were placed on the back wall using inverted knots (Figure 3B). Regular sutures were placed on the front wall (Figure 3C). Anastomosis was completed using 6-9 sutures. In the first 17 rats handled by the expert, all knots were made using the standard 3-throws. In the last 12 rats handled by the expert, all regular and inverted sutures were placed with 2-throw reef knots. The clamps were removed and gentle pressure was applied for 5 min. Immediate patency was assessed using the empty and refill test. The wound was finally closed and dressing was done. The animals were observed regularly in post operative period.

Animals underwent re-surgery after 2 weeks and the delayed patency was assessed (Table I).

After completion of the study by the expert, a beginner in the field of experimental microsurgery (a resident) performed end-to-end anastomosis (by the one way up method) using 2-throw reef knots in 5 rats. This step was performed to assess the

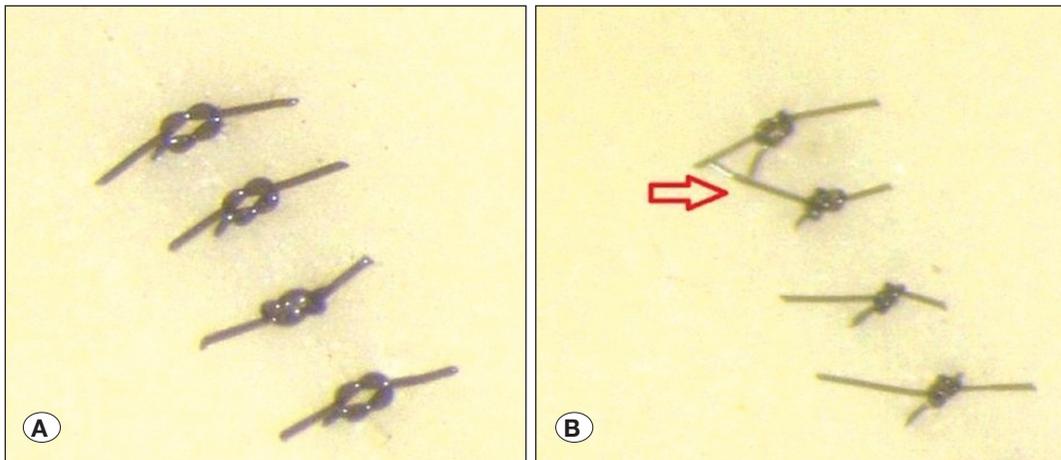


Figure 1: The Standard glove model showing (40x magnification): **A)** reef knots with 2 throws; **B)** reef knots with an additional third throw (arrow indicates “how a cut end can interfere while placing adjacent suture”).

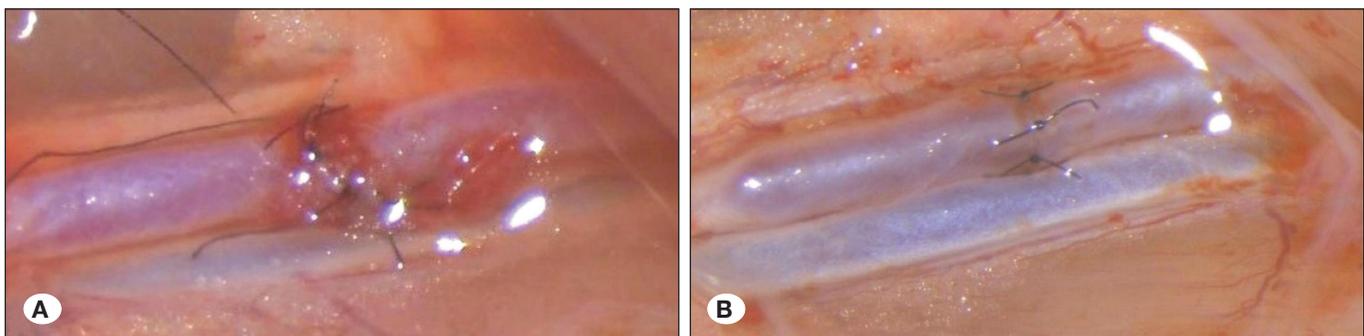


Figure 2: Demonstration of the anastomosis suture line (25x magnification): **A)** unclean suture line with “3” throws; **B)** clean suture line with ‘two’ throws.

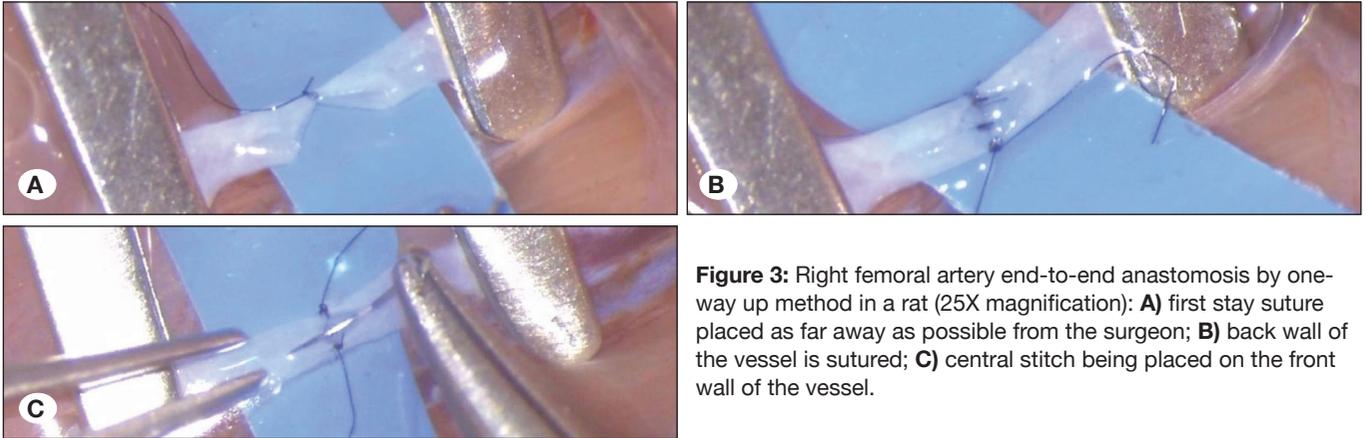


Figure 3: Right femoral artery end-to-end anastomosis by one-way up method in a rat (25X magnification): **A)** first stay suture placed as far away as possible from the surgeon; **B)** back wall of the vessel is sutured; **C)** central stitch being placed on the front wall of the vessel.

Table I: Patency Rates for the Expert

	Patency Rates (%)	p*
Immediate patency		
two throw reef knots (n=12)	100	0.06
traditional three throws (n=17)	82.4	
Delayed patency		
two throw reef knots (n=11) ^a	90.9	0.08
traditional three throws (n=16) ^a	62.5	

*: Chi-square test, **a**: one rat died in post operative period (due to unknown reasons) in each two throw reef knot and traditional three throw knot groups respectively.

safety of anastomosis performed with 2-throw reef knots by a beginner. The immediate and delayed patency rates were found to be 80% (n=5) in this case.

■ CONCLUSION

To the best of our knowledge, this is the first report describing the technique of microvascular anastomosis using 2-throw reef knots. This technique is feasible and probably superior to the anastomosis performed using conventional 3-throw knots. It is recommended that a trainee or a surgeon should master the technique of forming the 2-throw reef knot on a suitable model (e.g. glove/silicon tube) before performing it on animal or human subjects.

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