Animal Model for Microvascular anastomosis

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Technical nuances of side-to-side microvascular anastomosis and end-to-side microvascular anastomosis in the experimental Wistar rat model [1)].

The live rat animal model remains an indispensable model for many training microsurgical courses around the world. The use of this model in microsurgery training stretches back to the early 1960's, when pioneers such as Lee [2)] identified the need for low cost surgical models that could meet the clinical needs of the day. He and subsequent researchers went on to develop organ transplant models in the rat to help address the current immunological issues at that time. It became evident that there was a need to transfer these skills to the clinical sector, as these new microsurgical techniques opened up new surgical possibilities. This, in return, led to the establishment of microsurgical training courses utilizing the rat model across both shores of the Atlantic and the expansion of training [3)].

End-to-end, end-to-side, and side-to-side microvascular anastomoses are the main types of vascular bypass grafting used in microsurgery and neurosurgery. Currently, there has been no animal model available for practicing all three anastomoses in one operation. The aim of a study of Yin et al., was to develop a novel animal model that utilizes the rat abdominal aorta (AA), common iliac artery (CIAs), and the median sacral artery (MSA) for practicing these three types of anastomosis.

Eight adult Sprague Dawley rats were anesthetized and then laparotomized. The AA, MSA, and bilateral CIAs were exposed and separated from the surrounding tissues. The length and diameter of each artery were measured. The relatively long segment of the AA without major branches was selected to perform end-to-end anastomosis. One side of the CIAs (or AA) and MSA were used for end-to-side anastomosis. The bilateral CIAs were applied to a side-to-side and another end-to-side anastomosis.

Anatomical dissection of the AA, CIAs, and MSA was successfully performed on eight Sprague-Dawley rats; four arterial-to-arterial anastomoses were possible for each animal. The AA trunk between the left renal artery and right iliolumbar arteries was 15.60 ± 0.76 mm in length, 1.59 ± 0.15 mm in diameter, for an end-to-end anastomosis. The left CIA was 1.06 ± 0.08 mm in diameter, for an end-to-side anastomosis with the right CIA. The MSA was 0.78 ± 0.07 mm in diameter, for another end-to-side anastomosis with the right CIA or AA. After finishing end-to-side anastomosis in the proximal part of bilateral CIAs, the distal portion was juxtaposed for an average length of 5.6 ± 0.25 mm, for a side-to-side anastomosis.

This model can comprehensively and effectively simulate anastomosis used in revascularization procedures and can provide more opportunities for surgical education, which may lead to more routine use in microvascular anastomosis training. [4].

Cervical regions of Sprague-Dawley rats were dissected under intraperitoneal anesthesia. The step-by-step anatomic description was documented using a high-resolution charge-coupled device image sensor and recording systems. Using this model, temporal occlusion time and patency were measured, and these measures were compared between the trainee and trainer groups. The number of times the training needs to be completed to attain competency in the bypass procedure was estimated.

After exposing the carotid triangle, a half-ring was created by end-to-side anastomosis. Anastomosis was performed at the common carotid artery using the contralateral side of the carotid artery as a graft. The cutoff value for the temporal occlusion time was 79.3 minutes in the receiver operating characteristic curve based on a target temporal occlusion time for beginners determined during the training.

Using a living animal model, a trainee has the opportunity to learn not only anastomotic techniques but also hemostatic control as well as overcoming mental strain during surgery. Living animal models are important in training because the fidelity of a living animal model is superior to nonliving models. Applying training using a half-ring model contributes to safe and efficient surgery [5].

1)
Ortiz CL, Rodrigues Vera J, Cubides MC, González RS, Gutiérrez Morales JC. Technical nuances of side-to-side and end-to-side microvascular anastomosis in the experimental Wistar rat model. Acta Neurochir (Wien). 2024 Aug 13;166(1):335. doi: 10.1007/s00701-024-06219-3. PMID: 39136803.
2)
Lee S. Historical events on development of experimental microsurgical organ transplantation. Yonsei Med J. 2004;45:1115–1120.
3)
Green CJ. Microsurgery in the clinic and laboratory. Lab Anim. 1987;21:1–10.
4)
Yin X, Ye G, Lu J, Wang L, Qi P, Wang H, Wang J, Hu S, Yang X, Chen K, Wang D. A Novel Rat Model for Comprehensive Microvascular Training of End-to-End, End-to-Side, and Side-to-Side Anastomoses. J Reconstr Microsurg. 2019 Mar 5. doi: 10.1055/s-0039-1679957. [Epub ahead of print] PubMed PMID: 30836413.
5)
Mikami T, Suzuki H, Ukai R, Komatsu K, Kimura Y, Akiyama Y, Wanibuchi M, Mikuni N. Surgical Anatomy of Rats for the Training of Microvascular Anastomosis. World Neurosurg. 2018 Dec;120:e1310-e1318. doi: 10.1016/j.wneu.2018.09.071. Epub 2018 Sep 24. PubMed PMID: 30261400.