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International Journal of Cranio-Maxillofacial Surgery & Rehabilitation

Review Article

Suture-Less Anastomosis in Microvascular Surgery - A Literature Review

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How to cite: *Akash Sanjay Gupta, Suture-Less Anastomosis in Microvascular Surgery – Review. Int J Cranio Maxillofac Surg Rehab Volume 2022, Article ID 22109420, 6 pages.*

Received:15/03/22 *Accepted:30/03/22* *Web Published:12/04/22*

Abstract

The reconstruction of defects is one of the most intricate surgical procedures and commonly involves the process of vessel anastomosis. This anastomosis can be arterial or venous and is carried with the aid of a microscope with instruments specifically designed for the purpose. The common microvascular anastomosis practice involves the use of fine 8-0, 9-0, or 10-0 ethilon sutures. This method of anastomosis is highly technique sensitive and requires supreme surgical skills. With time, several suture-less anastomotic techniques were developed. This includes a stapler, vascular coupler, fibrin glue, lasers, and magnets. The literature review aims to elaborate on the efficacy, effectiveness, advantages, disadvantages, and applications of these suture-less anastomotic techniques in microvascular surgery based on existing literature evidence.

Keywords: *Free Flap, Microvascular Anastomosis, Suture-less, Reconstruction, Maxillofacial Defects*

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INTRODUCTION

The diseases and disorders of the oral and maxillofacial region are at times very extensive and can also exhibit a neoplastic nature, leading to the resection of a part of the maxillofacial region in toto. Such hard and soft tissue defects result from the resection of squamous cell carcinomas, salivary gland neoplasms, sarcomas, and primary bone neoplasms as well as defects related to osteoradionecrosis, trauma, and facial paralysis [1]. This puts the patient in a state of physical, physiological, and psychological trauma. The concept of reconstruction post-resection comes to the rescue of such patients and improves their quality of life.

The structural organization of the oral and maxillofacial region is quite complex and has many vital structures interspaced along with the hard and soft tissues. This poses a major challenge in reconstructing any defect in this region and requires accurate planning of treatment, meticulous care, and a skilled team of surgeons. The need to reconstruct multi-layered tissues is growing as there are a lot of surgical advancements [2]. Vascularised free tissue transfer also known as free flap transfer is the gold standard method of maxillofacial reconstruction. This technique is based on the concept of harvesting tissues from the donor site with their intact blood supply and using it to reconstruct the defect by anastomosing the flap to the recipient site's blood vessels. At present microvascular free flaps are considered the workhorse and standard of care for reconstructing large ablative defects of the oral and maxillofacial region [3]. The most common types of free vascular flaps are as follows: fibula free flap, radial forearm free flap, scapular free flap, and iliac crest free flap [3,4].

In the early postoperative period, the survival of the free flap largely depends on the arterial supply and venous drainage of the microvascular anastomoses. Historically, end-to-end anastomosis using hand-sewn sutures has been the most common method of anastomosis [5]. This method continues to be the preferred method of the anastomosis to date. However, with the advent of the latest technology, there are several other methods of anastomosis that have emerged in recent years. These methods include the use of LASER, fibrin glue, Vascular coupler, and stapler anastomosis.

The literature review aims to study the existing literature evidence on microvascular anastomosis and the type of sutureless anastomosis techniques used in microvascular surgeries. The review also aims at tabulating the applications, advantages, and disadvantages of different suture-less anastomotic techniques used in microvascular reconstruction.

MATERIALS AND METHODS

An electronic search was initiated for scholarly articles on sutureless anastomoses in microvascular surgery. The review consisted of two phases. Initially, the title and abstracts of the articles obtained through the search were reviewed and relevant articles were selected. The full-text access was obtained for the selected articles.

RESULTS

The search yielded 15 articles that were of high relevance to the current review and these consisted of a mixture of clinical studies and literature reviews. The 15 articles formed the basis of this literature review on the application of suture-less microvascular anastomosis in oral and maxillofacial surgery.

DISCUSSION

The conventional technique of microvascular anastomosis involves the placement of sutures at the cut ends of two vessels to establish anastomosis. The type of anastomosis can be an end-to-end anastomosis or an end-to-side anastomosis. Many authors have pointed out that the strength of anastomosis is directly proportional to the strength and number of sutures placed. Iskenderoglu et al. [6], in their literature review, have elaborated on the different methods of microvascular sutures that have been experimented with and reported by different authors. According to that review, some authors have used only interrupted or only continuous sutures, while some others have used a combination of both interrupted and continuous sutures. In case of diameter mismatch between the anastomosing vessels, the fish mouth technique was followed where the diameter of the narrow vessel was increased by widening it like a fish mouth. Some authors have also used interrupted eversion sutures. However, a major disadvantage of all these suturing techniques is that the strength of the sutures has been reported to be inversely proportional to the number of sutures placed. This means that as the number of sutures increases, the strength of the anastomosis decreases. Moreover, it is one of the most common reasons for damage to the vessel wall and subsequent complications. Hence, alternate methods of microvascular anastomosis were developed and are elaborated in detail below.

Fibrin glue-assisted anastomosis

The use of tissue adhesives can be considered the most simplest and more time-saving form of vascular anastomosis. Initially, cyanoacrylate glues were used for anastomosis. Histological examination of these vessels revealed that there was a narrowing of the lumen due to the hardening of the glue which also led to calcium release from the vessel walls, significantly affecting the hemodynamics [7]. Fibrin glue anastomosis was developed to avoid kinking and pressure on the vessel wall caused by conventional sutures. The application of fibrin glue for vascular anastomosis was first successfully carried out by Matras et al., [7]. Sacks et al. studied the use of fibrin glue for a novel technique of end-to-side anastomosis along with two-sided fish mouth sutures. The authors used only 2 sutures at the apex of fish mouth incisions and completed the anastomosis using fibrin glue. It was observed that this significantly reduced the intraoperative time without increasing the risk of thrombus or aneurysm formation. The fibrin glue also possesses an intrinsic thrombogenicity that mimics the coagulation cascade, which can compensate for any leakage at the periphery of the lumen. One major disadvantage of the fibrin glue technique is the possibility of the leakage of the adhesive into the vessel lumen, which is due to the lower tensile strength of the fibrin glue when compared with conventional anastomosis [8]. However, this can be prevented by the placement of some stay sutures alongside the fibrin glue anastomosis [9]. Bucherer et al., [10] analyzed the histological features exhibited by a vessel anastomosed using fibrin glue. They pointed out the reason for higher thrombotic rates in fibrin glue anastomosis to be the formation of thrombotic layers and impaired regeneration of endothelial defects. Further, the study also revealed that the critical time of anastomotic failure was prolonged and hence the study recommends a longer period of heparinization to compensate for the re-endothelialization time. Ritsch et al., [11] also support this view, as it was revealed in their study that the intraoperative time was reduced when fibrin glue was used. But due to the high thrombogenic potential, the authors term the use of fibrin glue as an inappropriate technique of anastomosis.

LASER assisted vascular anastomosis

The LASER used for vascular anastomosis is a Carbon dioxide laser, Nd-YAG laser, diode laser, and argon laser. Laser is based on the principle of an increase in temperature leading to adhesion by melting of collagen and coagulation of cells in the media and adventitia. In the case of argon lasers, protein bonds are degraded thermally allowing such proteins to rebind with adjacent proteins leading to a smooth tissue-to-tissue

connection, and anastomosis is achieved [7]. The penetration of the laser depends on the thickness of the vessel wall and absorption rate. The application of laser must be for a very limited time in the case of thin-walled vessels as over absorption might lead to intimal hyperplasia. Selva Kumar et al., [12] compared the effect of diode laser with conventional anastomosis in the reconstruction of orofacial defects. 3 stay sutures using 8-0 ethanol was placed at 120 degrees to each other and a diode laser of 810 nm wavelength was applied at a power of 2000mW in continuous mode. The facial artery, superior thyroid artery, and vein, external jugular vein, and internal jugular vein were used for anastomosis and all the vessels were anastomosed in the end-to-end fashion. Several advantages of using laser-assisted vascular anastomosis were observed in the study. There was a significant decrease in the anastomotic time which in turn decreased the overall operative time and ischemic time. The tunica media was intact without much damage and thrombus formation was also avoided. Another major advantage of using this technique is its flexibility to compensate for vessel diameter mismatches. Thus, LASER-assisted vascular anastomosis was found to be a very effective alternative to conventional micro-suturing anastomosis [12,13].

Vascular coupler/stapler anastomosis

The vascular closure stapler clip consists of an arcuate-legged titanium clip, with a stapler applicator whose head can be deployed at 360 degrees for the application of staplers. When this technique is used, 3-4 staysutures are initially placed around the vessel circumference. Now the vascular closure staples are applied at evenly spaced intervals around the vessel circumference [14]. The stapler or the coupler system does not leave any foreign object within the intima that has the potential to instigate a thrombus formation. It also can overcome vessel mismatches with discrepancies as large as the ratio of 3:1. This coupled anastomosis offers better lumen patency and is mechanically stronger than conventional anastomosis [15]. Yamamoto et al [16], point out some of the disadvantages of a vascular coupler or stapler anastomosis system. The choice of clip size must be accurate based on the thickness of the vessel and not merely on the vessel's caliber. This technique is disadvantageous when a proper coaptation of the vessel wall cannot be obtained due to thickened or sclerosed vessel walls. The clips should be applied one by one checking the coaptation of the vessel wall and might possess a challenge in the application at the posterior vessel wall. The learning curve of this technique is quite short and can be helpful in anastomosis if mastered perfectly.

Mudigonda et al., [17] compared the ischemic time, anastomotic time, patency, and leakage of all the above-discussed techniques with the conventional micro suturing technique. They've concluded that the non-suturing microvascular anastomotic techniques are safer and better alternatives only in case of venous anastomosis, as they can't withstand the arterial pressure in arterial anastomosis. There are other minor types of sutureless anastomosis that involve the use of magnets, stents, gels, bioabsorbable pin devices, and ring pin devices [18].

CONCLUSION

Based on the observations in this literature review, it is evident that suture-less anastomotic systems have not been completely implemented for microvascular surgeries and are serving as an adjunct to suturing anastomosis only. This can be attributed to the incomparable mechanical strength of suturing anastomosis. Hence, research should focus on the development of sutureless anastomotic techniques with better mechanical properties.

Financial support and sponsorship - Nil

Conflicts of interest - There are no conflicts of interest

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