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Use of a microvascular coupler device for end-to-side venous anastomosis in oral and maxillofacial reconstruction

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Abstract. The aim of this study was to compare the use of a microvascular coupler device (MCD) for end-to-side venous anastomosis (ETS group) and phleboplasties combined with MCD for end-to-end venous anastomosis (ETE group) in free tissue transfer for oral and maxillofacial reconstruction, with regard to the anastomosis time and occurrence of postoperative vascular crisis. The ETS group included 22 patients and the ETE group included 40 patients. Patient demographic data, anastomotic time, coupler size, microvascular complications, and flap survival rates were collected and analyzed. In the ETS group, the most suitable donor vessel size was greater than 2 mm, varying from 2 mm to 4 mm. The average anastomosis time was 3.35 ± 0.89 min in the ETS group and 7.80 ± 2.93 min in the ETE group; the difference between the groups was statistically significant ($p < 0.0001$). There were no statistically significant differences in complications or outcomes between the two groups. The ETS venous anastomosis with MCD technique is a better choice for anastomosis when the donor vessel size is greater than 2 mm. In those cases with mismatched veins, ETS venous anastomosis with MCD could significantly reduce the anastomosis time compared to ETE venous anastomosis with MCD after phleboplasties.

Key words: microvascular coupler device; end-to-side venous anastomosis; end-to-end venous anastomosis; vessel diameter.

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The microvascular coupling device (MCD) was first described by Berggren and Ostrup in 1987 as the Microvascular Anastomotic Coupler System (Synovis Micro Companies Alliance, Birmingham, AL, USA)[1]. Clinical and experimental data have shown that the use of MCD anastomosis is safe, time-saving, and has high patency rates when compared with the use of traditional hand-sewn anastomosis[1]. The use of the MCD technology has become mainstream in microsurgical techniques for venous anastomosis of free flaps in head and neck reconstruction following malignant tumour ablation[2,3].

Vascular occlusion is the main cause of failure in microvascular tissue transfer, with venous thrombosis being the primary cause more commonly than arterial insufficiency, and the greatest challenge for the clinician is how to improve the venous anastomotic patency rate in circumstances where there is a vessel diameter mismatch[4]. Several methods to overcome vessel size mismatch have been reported[4–7]. A previous study also showed that a lateral incision, Y–T enlargement, or wedge excision with the use of the MCD not only reduced the size discrepancy and the anastomosis time, but also decreased the difficulty level and improved the patency of the venous anastomoses[7]. Other methods such as invaginating, fish mouth, oblique section, and wedge excision have also been reported for mismatched venous anastomoses[4,8,9]. However, these studies focused mainly on end-to-end (ETE) venous anastomosis and only a few reported end-to-side (ETS) venous anastomosis with MCD reconstruction.

This retrospective review study was performed to compare ETS venous anastomosis with the MCD versus ETE venous anastomosis using the MCD after phleboplasties. The diameter of each vein, anastomosis time, occurrence of postoperative vascular crisis, flap survival, and complications related to the MCD were recorded.

Materials and methods

The cases of 62 patients treated between October 2013 and September 2017 were reviewed. All patients had undergone head and neck reconstruction following malignant tumour ablation at the Department of Oral and Maxillofacial Surgery, Xiangya Hospital of Central South University. All surgeries were performed by one surgeon (LH) with team members. The study protocol was approved by the Medical Ethics Committee of Xiangya Hospital of Central South University and the study was performed in accordance with the institutional guidelines. An informed consent agreement was signed by all participants. Age, sex, diagnosis, flap usage, vein size, anastomotic time, occurrence of postoperative vascular crisis, flap survival, and complications related to the MCD were collected and analyzed.

The MCDs were supplied by Synovis Life Technologies Company (Minneapolis, MN, USA). The MCD venous anastomoses during microsurgical reconstruction were performed according to the manufacturer's instructions and techniques reported previously in the literature[7]. A 'two-team' approach was used for all surgical procedures: one team harvested the flap and the second team performed the tumour resection.

In this study, a mismatch was defined as a recipient vessel to donor vessel diameter ratio greater than 1:2 and vice versa. An ETS venous anastomosis with MCD or ETE venous anastomosis with MCD after phleboplasties was performed when the size of the tributaries of the internal jugular vein or external jugular vein and the size of the donor vessel were mismatched. Patients with tumour recurrence usually only underwent ETS venous anastomosis with MCD, since the tributaries of the internal jugular vein or external jugular vein had been removed previously. Phleboplasties included lateral incision, Y–T enlargement, and wedge excision.

Following completion of the extirpative surgery and harvest of the flap, the donor vessel was measured using a coupler measuring gauge to determine the coupler size and the recipient vessel size. The recipient and donor vessels were then prepared appropriately for anastomosis. After the blood flow was blocked using vascular clamps, the ends of the recipient and donor vessels were passed through the lumens of the coupler rings and everted over the ring pins, then the coupler device was closed and the instrument was separated from the rings. Heparinized saline was used to rinse the vessels repeatedly during the vascular coupling. The time required for the preparation of the recipient and donor veins was not included in the anastomosis time. Postoperatively, vascular crisis, flap survival, and complications related to the MCD were recorded.

Photographs of typical ETS venous anastomoses using the MCD are shown in Fig. 1.

Results

Table 1 reports the clinical data of the patients included in this study. Single vessel anastomoses with the MCD were performed in all patients. The MCD was used for ETS venous anastomosis in 22 cases (ETS group), and the MCD was used for ETE venous anastomosis following phleboplasties in 40 cases (ETE group). ETS venous anastomosis with MCD was performed in three fibula flaps, five radial forearm flaps, and 14 anterolateral thigh flaps, while ETE venous anastomosis with MCD after phleboplasties was performed in five fibula flaps, 10 radial forearm flaps, and 25 anterolateral thigh flaps.

The distribution of the coupler sizes used in the study patients is shown in Table 2. In ETS venous anastomosis with MCD, the donor vessel sizes were all greater than 2 mm, varying from 2 mm to 4 mm. In ETE venous anastomosis with MCD after phleboplasties, the larger vessel size ranged from 4 mm to 8 mm, and the smaller vessel size ranged from 1 mm to 4 mm.

The time taken to perform the anastomosis in each group is shown in Table 3. The average anastomosis time in the ETS group was 3.35 ± 0.88 min, while it was 7.80 ± 2.93 min in the ETE group. The time taken to perform the anastomosis differed significantly between the two groups ($p < 0.0001$) (χ^2 test).

The occurrence of complications and the outcomes in this study are shown in Table 4. There were no statistically significant differences in complications or outcomes between the two groups.

The distribution of recipient vessels used in the ETS group is shown in Table 5. The recipient vessels were not limited to the internal jugular vein; other vessels such as the external jugular vein, common facial vein, and transverse cervical veins were also used.

Discussion

Over the past 20 years, use of the MCD has gradually become the mainstream for venous anastomoses in head and neck and breast reconstruction[1]. Several studies have shown that use of the MCD is an adequate alternative to hand-sewn techniques, because use of the MCD is less technically challenging and it decreases the anastomosis time and thrombosis rate[2,5,10]. Rickard et al.[8,11] and Wain et al.[12] investigated differences in the intravascular blood flow between MCD anastomoses and sutured anastomoses using computational fluid dynamics software. Their results showed that, when compared to the suture method, use of the MCD established the equivalent to a pristine vessel simulation by increasing the velocity profile and decreasing the wall shear stress and shear strain rate. Their results also indicated that the suture method was more prone to cause thrombus formation than the MCD anastomosis method. Ardehali et al. performed a systematic review of 13 case or group controlled trials using the MCD[1]. Among the total 2976 venous anastomoses performed using the MCD, thrombus formation occurred in 46 veins. The reported venous thrombosis rates in venous anastomoses using the MCD range from 0% to 3%. These rates are superior to those reported for thrombosis in hand-sewn venous anastomosis, which are as high as 10%.

Mismatches are common in microsurgical practice[4,6,13]. The rate of mismatch reported in a recent retrospective observational study