Systematic Review and Meta-Analysis
Reconstructive Surgery

One versus two venous anastomoses in microsurgical head and neck reconstruction: a cumulative meta-analysis☆

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Abstract. Venous compromise is still the most common cause of free flap failure. The use of two venous anastomoses has been advocated to reduce venous compromise. However, the effectiveness of this approach remains controversial. A systematic review and cumulative meta-analysis was performed to assess the effect of one versus two venous anastomoses on venous compromise and free flap failure in head and neck microsurgical reconstruction. A total of 27 articles reporting 7389 flaps were included in this study. On comparison of one versus two venous anastomoses, the odds ratio (OR) for flap failure was 1.66 (95% confidence interval 1.11–2.50; $P = 0.014$) and for venous compromise was 1.50 (95% confidence interval 1.10–2.05; $P = 0.011$), suggesting a significant increase in the flap failure rate and venous compromise rate in the single venous anastomosis group. These results show that the execution of two venous anastomoses has significant effects on reducing the vascular compromise and free flap failure rate in head and neck reconstruction.

With the many advances made in head and neck reconstruction, free microvascular flap transfer has become a routine procedure in microsurgical reconstruction. Free microvascular flap transfer offers many advantages over non-microsurgical reconstruction and significantly improves patient quality of life and survival rates[1–4].

Despite the advantages, there remains a postoperative complication rate of 30–47% and a risk of flap failure of 0–6%[5–8]. The most common flap complication that can lead to free flap failure is venous compromise, which accounts for more than 50% of flap failure[5,6,9,10].

A number of studies have analyzed different methods to improve the success rates of flap surgery by preventing venous compromise. These methods include the use of postoperative anticoagulants, an anastomotic coupling device (ACD), and the internal jugular system as the recipient vein. The execution of two venous anastomoses for venous outflow has also been advocated in reducing the risk of venous compromise and flap failure[11,12], with the assumption that the second vein will function as a back-up for the venous drainage when the primary venous anastomosis is occluded.

Although several studies have shown the benefits of two venous anastomoses

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in reducing venous compromise and flap failure[13,16], others have failed to show the same benefits[17–19]. Moreover, some studies have also reported several disadvantages of performing two venous anastomoses, such as the increase in operative time, reduction in blood velocity, and late detection of flap compromise leading to lower salvage success rates[17,19,20].

The aim of the present study was to resolve the continuing controversy regarding the use of one or two venous anastomoses in head and neck reconstruction. A systematic review and cumulative meta-analysis was performed to assess the effect of one and two venous anastomoses with regard to venous compromise and free flap failure in head and neck reconstruction.

Materials and methods

This systematic review was designed according to the PRISMA statement checklist and flowchart (Preferred Reporting Items for Systematic Reviews and Meta-analyses). In the cumulative meta-analysis, studies were added in order of their publication year to summarize the results evaluated as each new study was included.

Search strategy

A literature review was performed through a search of the MEDLINE (via Ovid; 1995–2016), Embase (via Ovid; 1995–2016), Web of Science (1995–2016), and Google Scholar electronic databases. The search strategy used the following key words: [''head and neck reconstruction''] OR [''free flap''] OR [''two venous anastomoses''].

A manual search of the reference lists of relevant articles and of conference abstracts was also performed in order to identify any ongoing studies or studies missing from the electronic databases. There was no limitation on language.

Inclusion and exclusion criteria

Relevant articles were included if they met the following criteria: (1) participants: patients undergoing free microvascular flap transfer in head and neck reconstruction. (2) Type of intervention: patients receiving either one or two venous anastomoses as outflow drainage. (3) Outcome: the primary outcome was the analysis of flap failure according to the use of one or two venous anastomoses. Secondary outcomes were the assessment of venous compromise and the salvage

success rate according to the use of one or two venous anastomoses. Studies that only reported these secondary outcomes were still included in the study.

The following were excluded: case reports, review articles, editorials, discussions, letters, and commentaries, and multiple articles by the same authors reporting similar data.

Study selection and data extraction

Two authors independently reviewed the titles and abstracts of the articles. If the abstracts fulfilled the eligibility criteria, the full-text articles were obtained for further review. Disagreements between the two authors were resolved by discussion. If any disputes remained unresolved, the senior author made the final decision. The following data were collected from the articles: authors, year of publication, location of the study, study design, number of patients in the study, types and numbers of flaps, number of venous anastomoses, number of flap failures, number of venous compromise, and number of successful flap salvage. These were analyzed to assess the outcomes, which included venous compromise, flap failure, and the flap salvage success rate.

Quality assessment

The quality of the included studies was assessed using the Newcastle–Ottawa scale (NOS)[21]. Three major categories covering a total of eight items were assessed: selection of the study groups (four items), comparability of the groups (one item), and ascertainment of the outcome of interest (three items). One point was given to each item if the study met that criterion, with the exception of the item 'comparability of groups' for which two points could be awarded. A study with a NOS score of 0–4 points was defined as being of low quality, whereas a study with a NOS score of 5–9 points was defined as being of high quality.

Statistical analysis

The binary outcomes, including flap failure, venous compromise, and salvage success rate, were analyzed by odds ratio (OR) with 95% confidence interval (CI). The OR was considered statistically significant for the outcome measured if the P-value was less than 0.05 with a 95% CI not crossing the value of 1 (equal odds).

A meta-analysis was performed using the software Stata 13.1 (Stata Corp. LP, College Station, TX, USA). Statistical

heterogeneity was assessed using the I^2 statistic. If the I^2 value was $>50\%$, the study was classified as having moderate to high heterogeneity[22]. The fixed-effects model using the Mantel–Haenszel method was to be used for an I^2 value of $<50\%$[23]. Otherwise, the random-effects model was to be used.

When a study contained no events in either or both arms of the study, the OR became undefined, causing problems in the computation of the treatment effect and standard errors[24,25]. To resolve this issue, 0.5 was added to each count in the contingency table for the study that contained no events.

Results

A total of 19,639 articles were identified from the electronic search of the MEDLINE, Web of Science, Embase, and Google Scholar databases. The manual search of the reference lists yielded another three articles. After removing duplicate articles, a further 12,349 articles were excluded on the basis of the title and abstract. The full texts of the remaining 36 articles were appraised, with nine articles excluded for not meeting the eligibility criteria (Supplementary Material, Table S1)[20,26–33]. A flow diagram of the study selection process is presented in Fig. 1.

Characteristics of the included studies

All 27 articles reported retrospective studies[13–19,34–53]. The included studies involved a total of 7389 flaps for head and neck reconstruction. One venous anastomosis was performed in 3976 (53.8%) flaps and two venous anastomoses were performed in 3413 (46.2%) flaps. Twenty-three articles were published in English and four in Chinese. All of the articles reported single-centre studies, with 12 studies conducted in China, six in the USA, four in Japan, two in Taiwan, and one each in Germany, South Korea, and India.

For all of the included studies, flap failure, venous compromise, and the salvage success rate in free flap transfer for head and neck reconstruction were evaluated in the one and two venous anastomoses groups. Twenty-five studies assessed the free flap failure rate[15–19,34–53], 21 assessed the venous compromise rate[13–18,34–36,39–50], and 15 assessed the salvage success rate[15–19,35,38,40–42,44–47,53].

The studies were also separated into two subgroups according to the type of flap used: non-osseous flap[13,15,17,19,34–47] or osseous flap[15,18,48,49]. The same analyses