REVIEW

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The microvascular reconstruction in children with maxillofacial defects: A Systematic Review

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ABSTRACT

Background: Facial bones trauma in the pediatric population is linked to severe damage and impairment, particularly in maxillofacial, particularly in area. In addition, reconstruction of maxillofacial in pediatric patients has some unique considerations. Therefore, this study described the effectiveness of microvascular reconstruction in children with maxillofacial defects.

Methods: The relevant literature from PubMed and Science Direct databases. The strategic search is using the keywords such as "Pediatric" OR "Children" OR "Under-eighteen years" AND "microvascular reconstruction" OR "microvascular surgery" AND "maxillofacial defect". We used a PRISMA method to the selection of those articles. The inclusion criteria were related to microvascular reconstruction in children with maxillofacial defects from 2000-2021.

Result: Total of six studies entries with inclusion criteria. These studies show that most free flaps or microvascular reconstruction procedures carried on pediatric patients to resolve maxillofacial defects gave successful functional, and clinical outcomes. In addition, a few complications, mainly infections, occurred following the surgery, however successfully managed with antibiotics.

Conclusion: A microvascular reconstruction is a good option for maxillofacial defects reconstruction in pediatric patients due to a shorter surgical time and faster recovery.

Keywords: Children, microvascular reconstruction, maxillofacial defect, outcome.
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INTRODUCTION

The maxillofacial defect that is not reconstructed can cause severe morbidities such as chewing, speech, and esthetic disturbances.[1] Especially the trauma or congenital disability that occurs in children.[2] Pediatric patients account for approximately 5 to 15 percent of total cases of facial fractures and increase with age.[1,3]

Pediatric patients are still prone to experiencing difficulties in reconstructing, especially in the maxillofacial section. Over the last ten years, microvascular tissue reconstruction techniques have been widely used by surgeons, and this technique makes it possible to transfer soft tissue and bone in a single stage without the limitation of pedicle length or vascular geometry.[4] There are still developments for this surgical technique, and few studies still discuss it. Even though some earliest reports of success microvascular free tissue surgery in children.[4-6]

Therefore, we are interested in discussing further through a systematic review to assess the effectiveness of microvascular reconstruction in pediatric patients who have experienced maxillofacial defects.

METHODS

This study was designed with a systematic review. The review has conducted the effectiveness of microvascular reconstruction in children with maxillofacial defects. We evaluate and interpret the qualified studies using the PRISMA method. We determine a research topic, research objectives and develop research questions before conducting search activities. The next step was to determine the keywords for the journal review. The author uses a logic grid method with the PICO approach to search for suitable keywords.

PubMed and Science direct were used to search valid studies. The keywords used from PICO in the literature search were "Pediatric" OR "Children" OR "Under-eighteen years" AND "microvascular reconstruction" OR "microvascular surgery" AND "maxillofacial defect". The criteria for this review are full-text English journals and observational studies from 2000 until 2021. After collecting the appropriate journals, we screened them based on the inclusion criteria. Finally, we report the value and outcome of studies for the analysis.

RESULT

Literature search

The literature study search process showed 4788 studies, with 4787 originating from online databases (PubMed, Science Direct, and Cochrane Library) and one analysis originating from data sources previously identified by the authors. In addition, there are 4126 studies obtained after removing duplicates using computer software (Citation Manager). Based on the title and abstract screening process, 147 studies were accepted to be assessed for eligibility (eligibility). Furthermore, 141 studies were excluded due to unsuitable

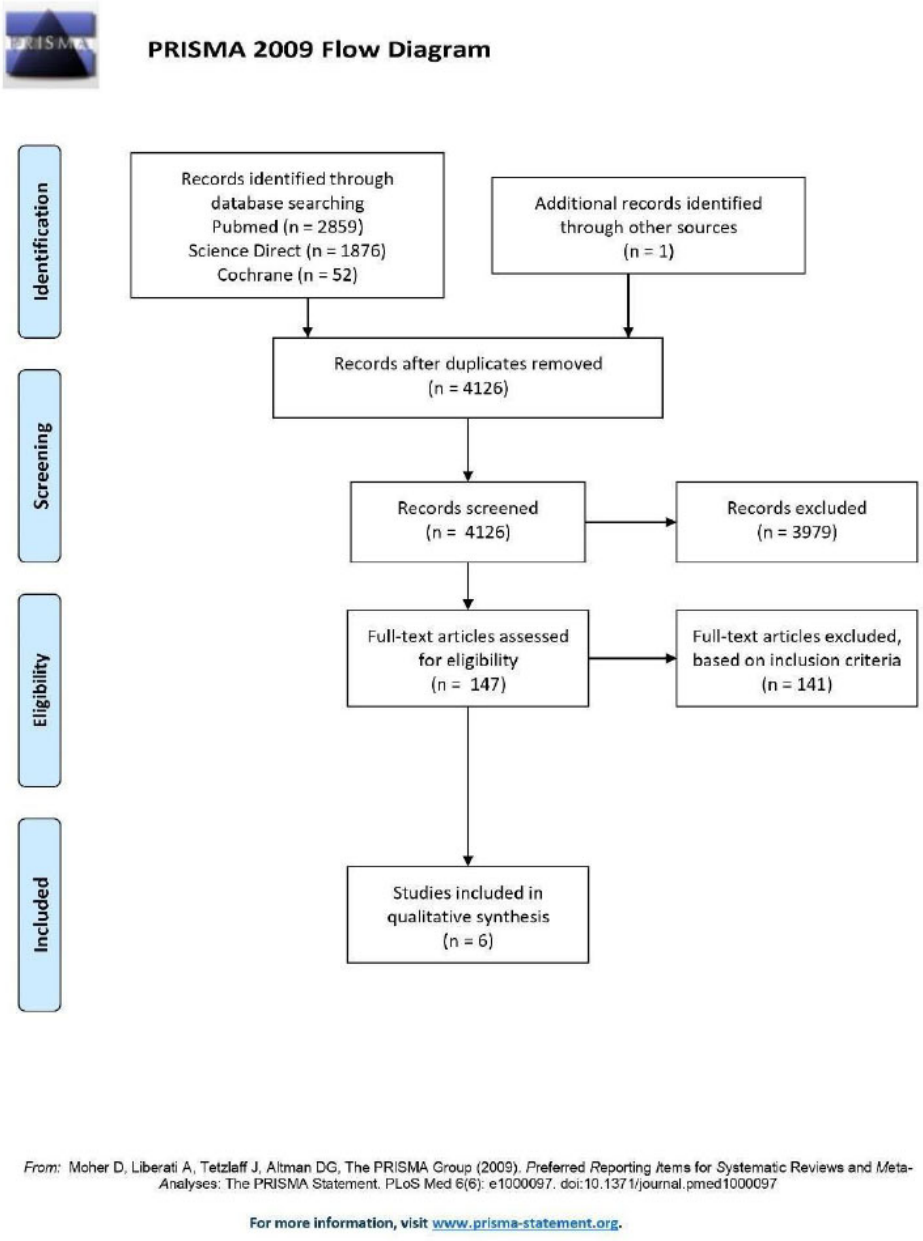

Figure 1. PRISMA *Flowchart*

inclusion and exclusion criteria, resulting in qualitative analysis using six included studies (systematic study). The entire literature search process follows the PRISMA Guideline and is summarized through a flowchart (Figure 1).

Data Characteristics

Data characteristics of all studies that meet the inclusion criteria are compiled in Table 1. All of the reviewed studies are retrospective studies written in English. The study designs include cross-sectional (2 studies), cohort (3 studies), and case-control (1 study). The follow-up periods range from 4 until 168 months. The total number of interventions is 47, whereas 45 interventions are microvascular reconstructions and the remaining 2 are conservative treatments using osteochondral rib graft reconstructions. The types of microvascular reconstructions are fibular (26 interventions), scapular (6 interventions), parascapular (4 interventions), dorsal (3 interventions), anterolateral thigh (2 interventions), radial forearm (2 interventions), fibular epiphyseal (1 intervention), and iliac (1 intervention) free flaps. The age range of the participants was 4-18 years old.

Outcomes of Studies

The outcomes of all studies included in this systematic review are summarized in Table 2. The results are categorized into three parameters: functional, clinical outcomes, and complications. Functional outcomes were assessed in three studies. Two of the studies evaluated functional outcomes of the free flap donor sites, and the results showed no functional deficit or impairment. Meanwhile, one of the studies showed no functional impairment in free flap patients at the donor and receiving sites. The orthopantomogram results showed a disproportionate growth in one patient with free flap in one study.

Clinical outcomes were assessed in all studies reviewed. Two studies had a 100% success rate of free flap procedures. Furthermore, free flaps in the other two studies achieved successful occlusion and gross facial symmetry. Two studies showed that the maximum mean of hospital stay was ten days. However, one study compared the clinical outcomes of the free flap and osteochondral rib grafts procedures that resulted in the shorter surgical time, faster NGFT and tracheostomy tube removal, and shorter duration of hospital stay. Lastly, complications of the procedures were recorded in five studies. One study showed no intra-and postoperative complications in free flap procedures. However, two studies recorded infections, and one study recorded partial skin paddle loss. In the study that compared free flap to osteochondral rib graft procedures, early infection and wound dehiscence requiring the flap to be removed and salvage reconstruction to be carried out was recorded in one free flap patient. Meanwhile, no complication was seen in osteochondral rib graft procedures.

Quality of Studies

The quality and bias assessment of the three cohort studies, two cross-sectional studies and one case-control study using the Newcastle Ottawa Scale (NOS) is presented in Table 2, with the mean score of 7.5 overall. A total of 2 studies are known to have moderate quality, and four studies have high quality.

Table 1. Data Characteristics.

Author (Year)	Follow Up (mo)	Study Design	Country	Type of Defect	Type of MR	Population			Conservative Intervention	Age
						MR	Conservative	Total		
Castellon (2018)[1]	-	Retrospective cross sectional	Chile	Maxillofacial defects	- 3 dorsal free flaps - 6 fibular free flaps - 1 anterolateral thigh free flap	10	-	10	-	4-17 yo
Comini (2019)[2]	36-84	Retrospective case-control	USA	Maxilary and mandibular defects	- 1 fibular free flap - 1 fibular epiphyseal free flap	2	2	4	Osteochondral rib graft	7-14 yo
Genden (2000)[3]	6-50	Retrospective cohort	USA	Maxillary (2) & mandibular (5) defects	- 2 fibular free flaps - 2 scapular free flaps - 2 scapular osteocutaneous free flap - 1 iliac free flap	7	-	7	-	8-16 yo (mean 13.2 yo)
Warren (2007)[4]	108-168 (mean 126)	Retrospective cohort	USA	Mandibular defects	- 4 parascapular osseocutaneous free flaps - 2 scapular osseocutaneous free flaps - 1 fibular osseocutaneous free flap - 1 fibular osseous free flap	8	-	8	-	6-17 yo
Cleveland (2017)[5]	6-54	Retrospective cohort	USA	Mandibular defects	- 4 fibular osteocutaneous free flaps - 1 fibular osseous free flap	5	-	5	-	10-18 yo (mean 14.6 yo)
Yang (2011)[6]	-	Retrospective cross sectional	USA	Head & neck defects	- 10 fibular free flaps - 2 radial forearms free flaps - 1 anterolateral thigh free flap	13	-	13	-	12-18 yo (mean 15 yo)

Note: MR = Microvascular Reconstruction

DISCUSSION

The trauma of the facial bones in the pediatric population is linked to severe damage and impairment, especially in the maxillofacial area. Motor vehicle injury, aggression, and falls are the most prevalent mechanisms of injury, which vary with age. Mandible injuries are observed more frequently among teenagers, whereas cranial and central facial injuries are more common among toddlers and newborns. These injuries continue to be a significant cause of mortality, morbidity, and hospital admissions.[7,8]

Pediatric patients account for approximately 5-15 percent of total cases of facial fractures and increase with age. Patients over sixteen years old take 1-14.7 percent of facial fractures in children, while only 1.0 percent are under five years old. Maxillary fractures take 1.2 to 20 percent of pediatric facial fractures.[9] The incidence rises as the maxillary sinuses mature and permanent teeth emerge, generally around the age of five, and peaks between the ages of thirteen and fifteen.[10]

Microsurgical reconstruction has recently been recognised as the most adaptable procedure for correcting extensive head and neck deformities. It has a significant effect on patients' quality of life, with a 97.5% success rate.[11] Patients who have undergone previous surgical treatment and medication may also benefit from microvascular-free tissue transplantation.[9] That was demonstrated from the many studies that have reported positive results of microvascular-free tissue transplantation in microsurgical reconstruction.[9-11]

Over the last 30 years, the success rate of microvascular free flap repair has increased from 70% to 90–99%, making it the most reliable surgery in the area of reconstructive surgery.[12–15] There has been research on the surgical periods for microvascular reconstruction. According to previous studies, the risk of rhabdomyolysis, deep vein thrombosis, and hypothermia increases with time of surgery[16,17] which could affect the effectiveness of microvascular reconstructions that have surgical periods ranging from 376 to 817 minutes.[18–21] Therefore, reducing the surgical time during the microvascular reconstruction will maximise the

Table 2. Outcomes of microvascular reconstruction in children with maxillofacial defects.

Author (Year)	Outcomes			Quality of Study (Score)
	Functional	Clinical	Complications	
Castellon (2018)[1]	-	100% success rate	-	Moderate (6)
Comini (2019)[2]	No functional impairment in both osteochondral rib graft and free flap patients	Osteochondral rib grafts: shorter operative time (median: 315 mins), faster removal of NGFT and tracheostomy tube (6–7 days post- op), shorter duration of hospital stay (maximum of 11 days), facial profile and symmetry were completely preserved	Early complications: No partial/total flap necrosis One free flap patient had local osteomyelitis and wound dehiscence with exposed bone within one mo post-op (required osteochondral rib graft for salvage reconstruction) No post-op complications were found at harvest and receiving sites in osteochondral rib graft patients No late complication	High (9)
Genden (2000)[3]	No functional deficit: Fibular donor site: no pain, no restriction to recreational activity after two years post-op Scapular donor site: normal ROM, strength, and shoulder stability Iliac donor site: no gait deficit, no pain within one mo post-op Two patients needed full dental rehabilitation: Able to have a regular diet No pain with chewing.	Gross facial symmetry & dental occlusion Immediate post-op recoveries Fibular donor site: normal limb length & circumference	No intra-op/post-op head & neck/donor site complication	Moderate (6)
Warren (2007)[4]	Scapular and parascapular donor site: normal shoulder strength and ROM Fibular donor site: Hallux can flex and extend No valgus deformity The transient lateral side of leg numbness; ankle weakness, instability, and stiffness; and foot pain and edema	Successful bridging of bone defects and integration of osseous flaps All patients gained mandibular symmetry and angle class I occlusion	Parascapular skin paddle was partially lost in 1 case	High (8)
Cleveland (2017)[5]		Mean operative time: 12 hours 100% flap success rate All patients underwent revision procedures to gain symmetry or to remove hardware Mean length of hospital stay: 10 days	No intra-op complication One patient had post-op tracheobronchitis (resolved with antibiotics) One patient had post-op superficial neck cellulitis (cured with antibiotics) No donor site complication	High (8)
Yang (2011)[6]		Mean length of hospital stay: 7 days	One patient had a minor wound infection	High (8

surgeon's work efficiency and reduce the risk of postoperative complications such as wound infections, hematomas, seromas, and dehiscence.[22] Anatomical limitations, such as vessel depletion or the difficulty of finding reliable recipient blood vessels, will increase the time of surgery. However, studies have shown no significant variations in flap complication and success rates based on perioperative treatment and surgical times. Nahabedian et al. (2004) also reported no correlation between the rates of flap necrosis and the choice of recipient's vessels or the timing of reconstruction.[23]

Preoperative radiotherapy has also been associated with a higher risk of free flap failure and complications due to microscopic and macroscopic vascular changes, leading to an increased risk of postoperative complications.[24–27] However, this result also correlates with surgeon planning, including assessing predicted anatomic and functional deficiencies, which are crucial in determining the best reconstructive choice in the preoperative and intraoperative periods. Moreover, a previous study reported that microvascular surgery has been successful among patients who have received multiple courses of preoperative radiation.

In addition to our included study showed that minimal intraoperative changes was required to achieve perfect bone alignment between the graft and native mandible, with an average of 12 hours surgical period. All patients tolerated the treatments, and no intraoperative problems occurred based on that timeframe. All flaps were viable after surgery, and no microvascular issues were discovered. Nonviable flaps did not require re-surgery.[5]

When compared to microsurgical procedures, microvascular reconstruction is a good option for maxillofacial defects reconstruction in pediatric patients due to shorter surgical time and faster recovery, functional outcomes, and maxillofacial growth patterns do not appear to be negatively affected.[2] In general, microvascular reconstruction had a lower complication rate than other treatments.

CONCLUSION

This review shows that most free flaps or microvascular reconstruction procedures carried on pediatric patients to resolve maxillofacial defects resulted in successful functional, and clinical outcomes. Few complications, mainly infections, occurred after the surgery were successfully managed using antibiotics. On the other hand, one study showed that free flap procedures were not as successful as osteochondral rib grafts, where the latter surgery was shown to give better radiologic and clinical outcomes, in which the patients managed to achieve facial symmetry with a shorter duration of surgery and hospital stay. In conclusion, there were not many studies and minimal sample size comparing the two surgical techniques to solve maxillofacial defects. Hence, further research of microvascular reconstruction and osteochondral rib grafts should be carried out to recommend a better treatment for maxillofacial defects in pediatric patients.

CONFLICT OF INTEREST

All authors declared that there is no conflict of interest related to the publication of this article.

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AUTHOR CONTRIBUTION

Each author has an equal contribution to the process of article writing.

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