Systematic Review and Guidelines for Perioperative Management of Pediatric Patients Undergoing Major Plastic Surgery Procedures, with a Focus on Free Tissue Transfer

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Background: Microsurgical free tissue transfer has been successfully implemented for various reconstructive applications in children. The goal of this study was to identify the best available evidence on perioperative management of pediatric patients undergoing free tissue transfer and to use it to develop evidence-based care guidelines.

Methods: A systematic review was conducted in the PubMed, Embase, Scopus, and Cochrane Library databases. Because a preliminary search of the pediatric microsurgical literature yielded scant data with a low level of evidence, pediatric anesthesia guidelines for healthy children undergoing major operations were also included. Exclusion criteria included vague descriptions of perioperative care, case reports, and studies of syndromic or chronically ill children.

Results: Two hundred four articles were identified, and 53 met inclusion criteria. Management approaches specific to the pediatric population were used to formulate recommendations. High-quality data were found for anesthesia, analgesia, fluid administration/blood transfusion, and anticoagulation (Level I Evidence). Lower quality evidence was identified for patient temperature (Level III Evidence) and vasodilator use (Level IV Evidence). Key recommendations include administering sevoflurane for general anesthesia, implementing a multimodal analgesia strategy, limiting preoperative fasting, restricting blood transfusions until hemoglobin level is less than 7 g/dl unless the patient is symptomatic, and reserving chemical venous thromboembolism prophylaxis for high-risk patients.

Conclusions: Pediatric-specific guidelines are important, as they acknowledge physiologic differences in children, which may be overlooked when extrapolating from adult studies. These evidence-based recommendations are a key first step toward standardization of perioperative care of pediatric patients undergoing plastic surgical procedures, including free tissue transfer, to improve outcomes and minimize complications. (*Plast. Reconstr. Surg.* 150: 406e, 2022.)

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Successful microsurgical free tissue transfer in children has been reported in the literature for over 40 years.[1] There was an initial hesitation to perform free flaps in children because of concerns about potential growth restriction, scarring, and the feasibility of the microsurgical anastomosis in submillimeter vessels.[2–4] With recent advances in microsurgical and supermicrosurgical techniques, successful pediatric free tissue transfer has been consistently reported for a variety of indications, even in infants and small children.[5–16] More recent studies are focusing on evaluating pediatric outcomes, with the goal of optimizing reconstruction and reducing complications.[5,17–20]

The saying that "children are not small adults" is often used to emphasize the anatomical, physiologic, and pharmacologic features that are distinctive to children.[21–23] For instance, cerebral immaturity and plasticity result in unique pain responses and medication sensitivity in children, and increased potential for harmful effects of anesthesia on neurodevelopment and behavior.[24,25] Normal physiologic parameters such as breathing rate undergo dramatic changes from infancy to childhood. Drug dose and clearance are affected by the child's size and the normal changes in total body water and other aspects of body composition that occur with age.[23,24,26,27]

There has been a growing interest recently in the development of evidence-based guidelines to guide perioperative management of patients undergoing free tissue transfer. Although several recent publications provide recommendations for perioperative care of adult free tissue transfer patients, no guidelines exist for children.[28–30] The goal of this study was to identify the best available evidence on perioperative management of pediatric patients undergoing free tissue transfer, and to develop evidence-based recommendations to optimize outcomes.

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PATIENTS AND METHODS

A systematic review of the literature was conducted in the PubMed, Embase, Scopus, and Cochrane Library databases from inception until May of 2019 following the standardized Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (Fig. 1).[31] Because of the scant, low-level evidence found on preliminary search of the pediatric microsurgical literature, inclusion criteria were expanded to include pediatric anesthesia guidelines for healthy children undergoing major operations. For each database, customized search strings were developed (Table 1). Pediatric patients were those aged 0 to 21 years, as defined by the American Academy of Pediatrics.[32–34] One thousand three hundred twenty-four records were identified, and ultimately 18 additional records were added based on manual review of full-text articles. Duplicates were removed, and two reviewers (P.M.M. and C.M.R.) screened the search results using the exclusion criteria in Table 2.

The full text of the remaining 204 articles was then assessed for eligibility, applying the exclusion criteria in Table 3, to identify key recommendations for perioperative care of pediatric free tissue transfer patients. Management approaches specific to the pediatric population were identified and sorted into six categories: patient temperature, anesthesia, fluid administration/blood transfusion, vasodilators, vasopressors, and anticoagulation. Additional data extracted from each article included patient age range, number of patients, study design, indication, and free flap type. Risk of bias and overall study quality were assessed by means of established Critical Appraisal Skills Program checklists.[35] Level of evidence was then categorized independently by the article reviewers, taking into account study quality as described previously.[28,36] The final recommendations were evaluated for potential quantitative comparisons, but no meta-analysis could be performed.

RESULTS

High-quality (Level I Evidence) data were found for all but patient temperature (Level III Evidence) and vasodilator use (Level IV Evidence) in the pediatric anesthesia literature, whereas the microsurgical literature provided Level III Evidence data for anesthesia and analgesia and Level IV Evidence data for all other categories. (**See Table, Supplemental Digital Content 1**, which shows pediatric-specific evidence-based recommendations, ***http://links.lww.com/PRS/F229***.)

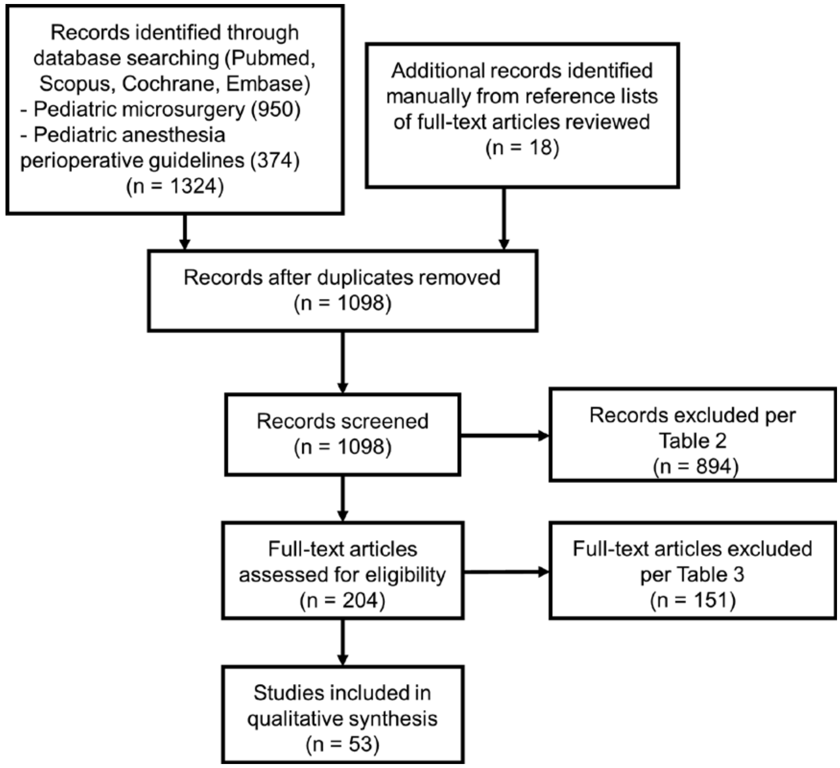

Fig. 1. Summary of literature search for systematic review.

Patient Characteristics

Of the 53 studies included in the analysis (Fig. 1), 34 provided specific data on both patient age range and number of patients. The remainder were systematic reviews and/or practice guideline-type articles that lacked this type of data granularity. Age range information was available for 4325 of the total 6947 patients (62 percent) included in our analysis. Although age ranged widely from 0.5 months to 18 years, the mean age was 7.2 ± 2.6 years.

Patient Temperature

Multiple studies in the microsurgical literature recommended maintaining normothermia,

Table 1. Custom Search Strings Used to Identify Relevant Literature in Each Electronic Database

Database	Custom Search Strings
PubMed	((((“pediatrics”[MeSH Terms] OR “pediatrics”[Title/Abstract] OR “pediatric”[Title/Abstract] OR “children”[Title/Abstract]) AND (“free flap”[Title/Abstract] OR “free tissue transfer”[Title/Abstract] OR “microsurgical reconstruction”[Title/Abstract])))
	((((((perioperative[Title/Abstract] AND “management”[Title/Abstract]) OR (“perioperative care”[MeSH Terms] OR (“perioperative”[Title/Abstract] AND “care”[Title/Abstract]) OR “perioperative care”[Title/Abstract])) AND (“pediatrics”[MeSH Terms] OR “pediatrics”[Title/Abstract] OR “pediatric”[Title/Abstract]) AND anesthesia[Title/Abstract] AND (“guideline”[Publication Type] OR “guidelines as topic”[MeSH Terms] OR “guidelines”[All Fields])))))
Embase	‘pediatrics’/exp AND (‘free tissue graft’:ab,ti OR ‘microsurgery’:ab,ti)
	‘perioperative period’/exp AND ‘child’/exp AND ‘anesthesia’/exp AND ‘practice guideline’/exp
Scopus	(INDEXTERMS (pediatrics) OR TITLE-ABS (pediatrics) OR TITLE-ABS (pediatric) OR TITLE-ABS (children)) AND (TITLE-ABS (free AND flap) OR TITLE-ABS (free AND tissue AND transfer) OR TITLE-ABS (microsurgical AND reconstruction))
	((TITLE-ABS (perioperative) AND TITLE-ABS (management)) OR INDEXTERMS (perioperative AND care) OR (TITLE-ABS (perioperative) AND TITLE-ABS (care))) AND (INDEXTERMS (pediatrics) OR TITLE-ABS (pediatrics) OR TITLE-ABS (pediatric)) AND TITLE-ABS (anesthesia) AND (DOCTYPE (guideline) OR INDEXTERMS (guidelines) OR ALL (guidelines))
Cochrane	‘“free tissue transfer” in Title, Abstract, Keywords or “free flap” in Title, Abstract, Keywords or “microsurgery” in Title, Abstract, Keywords and “pediatric” OR “children” in Title, Abstract, Keywords in Cochrane Reviews’
	‘“children” OR “pediatric” in Title, Abstract, Keywords and “perioperative” OR “postoperative” in Title, Abstract, Keywords and “care” OR “management” in Title, Abstract, Keywords in Cochrane Reviews’

Table 2. Exclusion Criteria Applied to Screen Literature Search Results, and Number of Records Excluded

Exclusion Criterion	Explanation	No. of Records Excluded
No free flaps	Studies without free flaps, or with free and pedicled flaps together without distinguishing the two	189
Not pediatric specific	Study population included adults and children, without considering pediatric patients separately	60
Other microsurgery	Microsurgical techniques other than free tissue transfer (e.g., organ transplant)	123
Not in English	Non-English language publications	148
Nonhuman study	Studies in animals, cells, and so forth	29
Not healthy children	Predominantly syndromic or chronically ill patients	109
Not major surgery	Ambulatory or other minor pediatric procedures	64
Outdated guidelines	Outdated pediatric anesthesia guidelines	30
Not general guidelines	Anesthesia recommendations that cannot be generalized to free tissue transfer patients	71
Case report	Studies of only a single patient	71

defined as core body temperature above 36°C, at all times for pediatric patients (Level V Evidence). Strategies to maintain normothermia included adjusting the operating room temperature, and the use of warmed blankets, intravenous fluids, and/or ventilation circuits.[3,37–39] A retrospective review of 32 free flap patients aged 2 years or younger recommended maintaining core body temperature at 38°C.[9] Both in this series and in a separate series of free flap patients aged up to 16 years, the authors supported normothermia by maintaining the operating room at a minimum of 27°C.[9,40]

The best quality evidence was found in the pediatric anesthesia literature, where a study of 1394 pediatric surgical patients indicated that the most common times for hypothermia are at the end of a long case and on arrival in the recovery room. Frequent temperature monitoring coupled with standardized interventions (e.g., warming blankets) reduced unplanned hypothermia incidence from 16 percent to 1.8 percent (Level III Evidence).[41]

Anesthesia

The pediatric microsurgical literature focused on adjuncts to general anesthesia, including epidural and regional blockades. Multiple retrospective reviews of pediatric patients undergoing free tissue transfer for lower extremity reconstruction included epidural anesthesia as a supplement to general anesthesia, or in combination with sedation (Level IV Evidence).[9,15,32,42,43] Similarly, for upper extremity reconstructions, several retrospective series described the use of brachial plexus blockade.[14,40,43,44] Two small comparative studies of pediatric patients undergoing upper extremity microsurgery indicated that sympathetic blockade increased arterial flow in digital replantations and toe-to-hand transfers, and reduced the rate of reoperation (Level III Evidence).[45,46]

Table 3. Exclusion Criteria Applied to Full-Text Records to Determine Eligibility in the Systematic Review and Number of Records Excluded

Exclusion Criterion	No. of Records Excluded
No pediatric free flaps described	4
No mention of any specific perioperative management parameters	123
Not major surgery: ambulatory or minor pediatric procedures	2
No definitive practice guideline or recommendation	22

The pediatric anesthesia literature offered high-level evidence on this topic, recommending ultrasound guidance for regional blocks and epidurals (Level I Evidence). A Cochrane Review of 20 randomized trials found that ultrasound guidance decreases the time to perform the block, reduces the number of failed blocks, and reduces the rate of failed blocks—with a greater reduction in younger children.[47] However, combining blocks with general anesthesia carries a higher risk of morbidity in children, and should be implemented only if an experienced anesthesiologist is available.[48] A practice guideline from Europe recommended avoiding intravenous induction of general anesthesia, particularly in young children and infants, to avoid the need for establishing painful vascular access while the child is awake.[39] Sevoflurane was recommended for induction and maintenance of pediatric general anesthesia because of its safety profile and rapid induction/emergence (Level I Evidence).[49] To reduce emergence delirium/agitation, 1 mg/kg of propofol should be given at the end of sevoflurane anesthesia (Level I Evidence).[50]

Fluid Administration and Blood Transfusion

Perioperative fluid management and blood transfusion thresholds were seldom described in the pediatric microsurgical literature. Several retrospective case series with indications ranging from facial palsy to extremity reconstruction maintained fluid supplementation for 5 to 7 days postoperatively.[38,51,52] The fluid rate administered was 1.5 to two times the maintenance dose.[3,38,51,52] One series of 99 pediatric free flaps reported a transfusion rate of 60 percent, but did not list a transfusion threshold.[52] Several series restricted transfusions until the hemoglobin level was less than 7 g/dl.[15,38] Compared to a higher value of 9.5 g/dl, a multicenter, prospective, randomized, controlled trial demonstrated that this lower threshold reduces transfusion-related morbidity in hemodynamically stable children without lengthening intensive care unit stay or increasing risk of multiple organ dysfunction (Level I Evidence).[53]

In the pediatric anesthesia literature, recommendations for preoperative fasting and intravenous fluid type are evolving. High-level evidence supports the preoperative fasting durations known as the "2-4-6 rule," wherein infants and children fast from clear liquids for only 2 hours before surgery, and from breast and nonhuman milk for 4 and 6 hours, respectively (Level I Evidence).[39,49,54,55] However, multiple European pediatric anesthesia societies have issued recent guidelines of 0- to 1-hour fasting for clear liquids, with volume not to exceed 3 ml/kg/hour.[50,56] A prospective cohort of 150 children allowed to consume clear liquids until the time of surgery had a decreased incidence of hypotension and similar morbidity/mortality, compared to a retrospective cohort abiding by the 2-4-6 rule (Level III Evidence).[57] Good evidence was found for using balanced electrolyte solutions with 1% to 2.5% glucose, rather than isotonic normal saline with 5% glucose, to avoid hyperglycemia and better approximate the normal volume and composition of extracellular fluid (Level II Evidence).[22,39,50,58] An initial perioperative fluid infusion rate of 10 ml/kg/hour was suggested.[58] Several studies reported that the colloid hydroxyethyl starch 130/0.4 at a dose of greater than or equal to 20 ml/kg interferes with the coagulation cascade and significantly increases blood loss.[22,58]

Analgesia

Data regarding analgesia were sparse in the pediatric microsurgical literature, with the exception of extremity reconstruction studies, where regional blockades used for intraoperative anesthesia were continued postoperatively.[9,15,32,40,43,45,46,59] Several studies reported reduced opiate needs and/or improved flap outcomes (Level III Evidence).[15,45,46]

In the anesthesia literature, multiple high-quality studies supported a multimodal strategy including acetaminophen and/or nonsteroidal anti-inflammatory drugs. A meta-analysis of 27 randomized controlled trials concluded that administering nonsteroidal anti-inflammatory drugs postoperatively reduces opioid requirements in the first 24 hours after surgery, whereas systemic acetaminophen significantly reduces pain scores (Level I Evidence).[60] The reduction in postoperative opiate requirements was supported by several other studies comparing around-the-clock regimens of acetaminophen and/or ibuprofen and/or diclofenac.[39,48–50,61,62] As a single agent, diclofenac had the highest opioid-sparing effect in children (Level I Evidence).[39]

Anticoagulation

The most recent recommendations regarding anticoagulation of children were similar in the pediatric microsurgical and anesthesia literature, with high-quality evidence in the latter. Venous thromboembolism prophylaxis in children and adolescents should be determined based on risk assessment, with early ambulation and sequential compression devices as the first line, and chemical prophylaxis reserved for high-risk patients (Level I Evidence).[63] High risk was routinely defined as altered mobility for greater than 48 hours and two or more venous thromboembolism risk factors.[63,64] Several larger pediatric free tissue transfer series reported reduction in bleeding complications and flap loss when routine chemical prophylaxis was withheld (Level IV Evidence).[2,7,15,37,40,51,52,65–68] These studies, together with several smaller studies, recommended that anticoagulation be reserved for special cases, including very small-caliber vessels (e.g., children younger than 4 years); obvious vessel disease or damage; intraoperative thrombosis; and following anastomosis revision.[69–72] Pediatric free tissue transfer series frequently reported the use of low-molecular-weight dextran-40 (8 to 10 ml/kg/day),[7,73–78] aspirin (75 to 81 mg/day),[38,51] or a combination of these agents.[2,42,43,47,79] The pediatric anesthesia literature recommends premedication before dextran administration in children, because of the significant risk of anaphylaxis.[22] More recent publications have shifted away from dextran and instead recommend enoxaparin in high-risk patients, typically 0.5 mg/kg/dose subcutaneously twice daily in children that weigh less than 45 to 50 kg.[63,64]

Vasodilators

Topical vasodilator use was not described in pediatric anesthesia guidelines, and was described in only a few publications from the pediatric microsurgical literature (Level IV Evidence). Four case series and one systematic review were identified that discussed this topic, all for pediatric extremity reconstruction.[9,14,37,40,42] Topical vasodilators were most frequently applied to the microsurgical anastomosis, and included papaverine, 2% lidocaine, and 0.1 mg/ml verapamil in saline. Verapamil has been described for extremity reconstruction in patients of all ages, including in a series of 32 children aged 5 months to 2 years.[9,14,40]

DISCUSSION

Infants, children, and adolescents pose unique considerations as surgical patients, ranging from positive factors such as reduced medical comorbidities and rapid wound healing, to challenges because of growth considerations and immature organ systems.[21,23] Although significant focus has been placed on optimizing perioperative care and developing enhanced recovery after surgery protocols for adult patients undergoing microvascular reconstruction, little has been done to standardize the perioperative care of pediatric patients. Despite technical challenges, free tissue transfer in pediatric patients has successfully been performed for over 40 years and in infants as young as 4 months.[1,7] Several large series have reported success rates as high as 99.8 percent.[7,37] This study aimed to synthesize the best available evidence from the pediatric anesthesia and microsurgical literature to develop evidence-based guidelines to optimize outcomes. Six modifiable perioperative factors were identified: temperature, anesthesia, fluid administration/blood transfusion, analgesia, anticoagulation, and vasodilator use. High-level evidence was identified from the pediatric anesthesia literature, which can be used to guide the perioperative management of healthy children undergoing pediatric plastic surgery procedures. Special attention was paid to the pediatric microsurgical literature, to identify existing evidence, albeit scant, and underscore areas for future study.

Temperature regulation is an excellent example of the unique considerations necessary for pediatric microsurgical patients. Children, and particularly infants, are more prone to heat loss in the operating room because of a higher surface area–to-volume ratio. Neonates in particular are at risk, as they have immature thermoregulatory responses.[41] In contrast to the adult microsurgical literature, which recommends maintaining average body temperature at 37°C intraoperatively and ambient operating room temperature at 24°C,[28] we found evidence to support higher set points in young children: 38°C and 27°C, respectively (Level IV Evidence).[9,40] The absence of high-level evidence likely reflects the ethical considerations when dealing with pediatric patients and the widely recognized negative consequences of hypothermia, both in terms of systemic effects such as respiratory depression and metabolic changes, and infection and other perioperative complications.

The vulnerability of the developing brain to potentially neurotoxic anesthetic and analgesic agents is another unique factor in perioperative care of pediatric patients. Although early studies raised concerns about neurotoxicity associated with even a single exposure to general anesthesia in childhood, large sibling-matched cohort studies have fortunately not shown any adverse effect on neurodevelopment or cognition.[24,50,80,81] Nevertheless, numerous sedative and general anesthetic medications carry a "black box" warning from the U.S. Food and Drug Administration regarding a potential risk of impaired neurodevelopment in children younger than 3 years exposed to these medications for over 3 hours, or to multiple shorter procedures; the specific medications bearing this warning are desflurane, halothane, isoflurane, sevoflurane, etomidate, ketamine, lorazepam, midazolam, methohexital, pentobarbital, and propofol.[82–84] Our review identified sevoflurane as the "ideal" agent for general anesthesia in the pediatric population (**see Table, Supplemental Digital Content 1**, ***http://links.lww.com/PRS/F229***).[49,50] It is important to note that the U.S. Food and Drug Administration warning was largely based on preclinical data from rodent and nonhuman primate models. A recent multicenter, randomized, controlled trial comparing awake-regional to sevoflurane-based general anesthesia in 722 children younger than 60 weeks demonstrated no long-term adverse effect on neurocognitive and intelligence scores at 2 years and 5 years of age.[85,86] An additional recent study of 997 children exposed to various general anesthetic agents before age 3 years demonstrated no adverse effect on intelligence scores a decade or more later, but suggested that multiple exposures to these medications correlated with adverse behavioral outcomes.[87]

Based on our review, general anesthesia is the standard of care for pediatric free tissue transfer, likely because of the duration of the procedure and the complete immobility that can be achieved with this technique. However, the pediatric microsurgical literature supports the use of locoregional blockades not only for postoperative analgesia but to optimize arterial flow in upper extremity reconstruction (Level III Evidence).[45,46] These techniques carry a risk of significant morbidity, including permanent neurologic deficit, and the anesthesia literature supports the use of ultrasound (Level I Evidence) by an experienced anesthetist.[47,48] Such a multimodal approach can also be beneficial in terms of avoiding neurotoxicity in the postoperative period. Children have unique pharmacokinetics because of altered protein binding and maturing organs, which can alter the rate of opiate metabolism.[48] In addition, pain assessment can be a challenge in young children, which makes continuous or scheduled infusions preferable. High-level evidence supports the use of scheduled nonsteroidal anti-inflammatory drugs (Level I Evidence) to decrease opiate needs for perioperative pain control.[60]

Despite the known correlation between fluid overload and flap failure in adults,[88,89] the pediatric microsurgical literature rarely describes strategies for perioperative fluid management. In contrast, optimizing perioperative fluid balance is the subject of active study in the pediatric anesthesia literature.[22,90–92] Although high-level evidence supports the 2-4-6 rule for preoperative fasting, recent studies are demonstrating the safety of even further reductions in fasting from clear liquids.[50,56] A prospective study allowing children to drink clear liquids until the time of surgery, compared to historic controls from the 2-4-6 rule, demonstrated significant reductions in perioperative morbidity/mortality, and significant reductions in other factors, including the incidence of postoperative hypotension, a factor that would directly impact microvascular outcomes.[57]

Transfusion criteria remain a controversial topic in the microsurgical literature, with common practice often deviating from the conservative threshold value supported by high-level evidence from the adult and pediatric anesthesia/critical care literature (hemoglobin level <7 g/dl).[28,53,93] In a survey of practicing microsurgeons, over 60 percent reported perioperative transfusion thresholds of 7 to 8 g/dl or higher.[93] Multiple studies in the adult microsurgical literature have analyzed anemia as a predictor of flap failure, with conflicting results; some studies have supported transfusion at a hemoglobin level of less than 10 g/dl (hematocrit <30 percent), whereas others have reported decreased risk of flap loss if transfusion is restricted to a hematocrit value of less than 25 percent.[28,94–96] A recent study of 168 adult patients undergoing free tissue transfer found that although flap loss was more common in patients receiving transfusions, perioperative anemia was actually the variable that significantly predicted flap loss based on multivariate statistical analysis.[97] Their analysis suggested that the threshold for transfusion should be a hemoglobin level of 8.75 g/dl.[97] Although the available evidence in the pediatric anesthesia literature (Level I Evidence) does not support more liberal transfusion criteria, these findings from the adult microsurgical literature are important to consider to optimize flap outcomes, and underscore the limitations of extrapolating directly from the anesthesia literature.

Venous thromboembolism prophylaxis is an area where the unique physiology of children results in alternate recommendations from those for adults. Infants and children have a reduced thrombotic potential compared to adults, because of a combination of factors, including reduced thrombin-forming ability, reduced circulating concentrations of vitamin K–dependent clotting factors, and increased levels of thrombin inhibitors.[98] These findings support the many pediatric microvascular series that reported not administering any routine anticoagulation in the absence of anastomotic complications or otherwise elevated thrombotic risk.[15,32,52,65,67,70,71,99] For extremity reconstruction, we found use of dextran to be widely reported.[2,7,42,43,47,73–79] This likely reflects historic practice, as more recent studies in the adult literature have linked this agent to increased morbidity, including flap failure.[100,101] In children, there is also a significant risk of anaphylaxis.[22] We thus recommend venous thromboembolism prophylaxis only in high-risk patients, and the use of enoxaparin as a first-line agent.

Vasodilator use is a factor that could not be extrapolated from the pediatric anesthesia literature, as these agents are not typically used in otherwise healthy children. This underscores a main limitation of our study, which is a relative dearth of pediatric microsurgery publications. These cases are relatively rare compared to adult free tissue transfer, and thus the existing literature has focused on establishing the feasibility of these techniques. Perioperative details are often omitted in favor of describing complications and outcomes. Because of the vulnerable nature of pediatric patients, there are ethical considerations that limit our ability to design studies that will provide high-level evidence. In the meantime, we encourage continued reporting of perioperative details in new publications, particularly those by higher volume centers, to facilitate refinements that will improve our outcomes and minimize complications.

CONCLUSIONS

Although free tissue transfer in infants and children is challenging, reliable results have been reported for a wide variety of indications. With recent advances in microsurgical practice, an increased focus has been placed on optimizing outcomes, particularly in adult patients. Unfortunately, these guidelines cannot be directly extrapolated to pediatric patients because of unique anatomical, pharmacokinetic, and physiologic differences. In this work, we reviewed both the microsurgical and pediatric anesthesia literature to identify the best evidence-based guidelines for perioperative care of these special patients. These recommendations are a first step toward standardization of perioperative care in pediatric free tissue transfer and serve as a basis for future studies of methods to further optimize patient care and outcomes.

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