

Reconstruction in the Growing Child: How Growth Alters Timing, Tissue Selection and Long-Term Outcomes in Paediatric Reconstructive Surgery

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Abstract

Paediatric reconstruction must remain functional as the recipient site, donor site and child's needs change through growth. Wound closure and flap survival are therefore necessary but incomplete measures of success. This narrative review examines how growth influences reconstructive timing, soft-tissue and bone selection, burn reconstruction, donor-site morbidity, surveillance and outcome assessment across craniofacial, limb and trunk defects. Targeted web-assisted retrieval of PubMed-indexed records, accessible full texts and publisher pages was used to support a purposive synthesis of clinical and methodological literature available through October 2026. Study findings were interpreted qualitatively; no new meta-analysis or statistical testing was performed. Paediatric free-tissue transfer achieves high technical success in selected cohorts, but predominantly observational evidence does not establish equivalence with adults or the superiority of one reconstructive strategy. Soft tissues may accommodate growth, whereas remodelling of transferred bone should not be equated with predictable longitudinal growth. Mandibular asymmetry, malocclusion, ankle deformity, scar restriction and donor-site dysfunction can emerge after an initially satisfactory reconstruction. Developmental durability is proposed as a clinical organising concept encompassing sustained function and proportion, acceptable donor-site development, preserved future options and manageable revision burden. It is not a validated composite outcome. Planning should incorporate multidisciplinary assessment, age-appropriate participation in decisions and follow-up through relevant developmental transitions to skeletal maturity. Prospective multicentre studies should distinguish technical survival from growth, function, psychosocial well-being and the cumulative burden of treatment.

Categories: Plastic Surgery, Pediatric Surgery, Pediatrics

Keywords: burns, donor-site morbidity, free flap, growth, long-term outcomes, microsurgery, paediatric reconstruction, plastic surgery, vascularised fibula

Introduction And Background

Paediatric reconstruction is performed at one developmental stage but must function through several others. Congenital anomalies, trauma, burns, tumour ablation and complex wounds may require tissue replacement during infancy or childhood. Treatment must address the presenting defect while protecting skeletal development, joint motion, dentition and the functions relevant to the anatomical region. A technically successful repair can become inadequate as scars restrict movement, transferred tissues adapt differently from adjacent structures and the demands placed on the reconstruction increase [1-3].

Flap survival, wound healing and early complications remain essential outcomes, but they do not describe the child's entire reconstructive course. Recent work has combined viability, donor-site healing and functional recovery, illustrating interest in broader assessment while also highlighting the need to validate composite measures [4]. In this review, developmental durability denotes the ability of a reconstruction to maintain useful function and acceptable proportion while limiting donor-site morbidity and the cumulative burden of secondary procedures through growth. This is a proposed clinical concept rather than an established scoring system.

The review examines how growth changes reconstructive timing, tissue selection, donor-site assessment and surveillance. It integrates evidence across selected craniofacial, limb, trunk and burn indications to identify practical principles and unresolved questions; it does not attempt to catalogue every paediatric defect or determine a universally superior operation.

Methods

This critical narrative review used purposive retrieval of PubMed-indexed records, accessible full texts, publisher pages and reference lists. Focused searches were executed in October 2026 through NCBI PubMed Entrez E-utilities using ESearch and EFetch. Appendix 2 reports the exact syntax, field tags, date bounds, retrieval limits and recorded search returns. The final synthesis cites 35 publications; this is a retained-

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source count, not an estimate of all records originally screened.

English-language clinical reports were considered when they concerned reconstruction in patients aged 18 years or younger, or provided identifiable paediatric observations in a mixed-age series. Sources needed to address reconstructive feasibility, growth, recipient or donor function, complications, revision or patient-reported outcomes. Relevant reviews, outcome-instrument development and registry-methodology reports supplied context. Serial growth or functional observations and clearly defined denominators were prioritised; full-text findings were used where available. Appendix 4 distinguishes these source classes and gives operational inclusion and exclusion rules.

Appraisal was qualitative. Conflicting findings were considered against case mix, defect severity, outcome definition, follow-up and attrition; different endpoints were not treated as interchangeable. Numerical findings retain their source attribution and patient, flap, graft or procedure denominator. No new pooling or statistical testing was performed. Selection was not independently duplicated, and no registered systematic protocol, formal risk-of-bias scoring or certainty grading is claimed. The search counts in Appendix 3 describe the focused update only.

Review

Why growth changes the reconstructive problem

Growth is not uniform enlargement. Craniofacial structures, long-bone physes, dentition and soft-tissue envelopes mature at different rates. A reconstruction may preserve volume but lose proportion, or maintain contour while restricting movement. Soft-tissue accommodation, osseous remodelling and longitudinal growth should therefore be distinguished. Flaps can change in size and composition; transferred bone can remodel under load; but these observations do not establish that a non-physal bone segment has acquired the growth behaviour of the native skeleton [2,3].

A fasciocutaneous flap may provide durable coverage yet require contour adjustment as body composition changes. Muscle bulk and function depend on innervation, loading and the purpose of transfer. For osseous reconstruction, the growth of retained native structures may contribute to an apparently enlarging reconstructed segment [2,5]. Planning should account for remaining growth, the tissue transferred and the functional consequences of a later mismatch, rather than assuming that all living tissue will grow proportionately.

Timing as a balance between developmental benefit and revision burden

Delay is not necessarily protective. Reconstruction may be required to cover exposed structures, permit treatment of a tumour or preserve function during development. Conversely, an elective definitive procedure may consume donor tissue or introduce a construct requiring adjustment with growth. The relevant questions are which function is time-sensitive, whether postponement risks irreversible harm and how the proposed reconstruction will be reassessed as the child matures [1,2].

Craniofacial conditions illustrate the need to balance immediate functional concerns with later skeletal development. Airway compromise, ocular protection and intracranial problems may determine priorities independently of aesthetic refinement [6]. Staging can preserve options and distribute treatment, but additional admissions, anaesthesia, school absence and family disruption must also be considered. These are planning considerations, not evidence that either early definitive reconstruction or staged treatment is universally preferable. Discussion with the family should describe a plausible treatment pathway, with age-appropriate involvement of the child, rather than promise a single permanent operation.

Microsurgical soft tissue reconstruction

Thakkar and Bednarz identified 10 studies comprising 220 free flaps for paediatric lower-extremity injuries, with 10 complete failures and an overall reported success rate of 95.5% [7]. Upton and Guo described a separate 29-year experience with 433 paediatric free-tissue transfers across several anatomical regions [8]. These findings support technical feasibility in experienced centres. They do not establish equivalence with adults, because indications, patient selection, denominators and follow-up differ.

A recent cohort illustrates why the relevant denominator and case mix must remain visible. Borowiec et al. reported 54 head-and-neck free-flap procedures in 46 paediatric patients, with overall flap survival of 76%; the mean composite treatment-effectiveness score was summarised for cases without flap loss. This survivor-conditioned score cannot describe the entire reconstructive cohort or be compared directly with lower-limb trauma survival estimates [4]. In a 2025 orthoplastic cohort of 94 children, Mistry and Khan reported follow-up flap outcomes for 53, among whom one total and one partial failure were recorded. Those observations should retain the follow-up denominator and do not establish growth compatibility for the original cohort [9].

Longer-term recipient-site behaviour can differ despite similar early viability. Lin et al. reported 106 free flaps used in 91 children with foot and ankle defects, including secondary transfers. Their retrospective comparison identified more secondary deformities and resurfacing procedures after skin-grafted muscle flaps than after flaps containing a skin component [10]. This association is clinically relevant, but flap choice was not randomised: defect characteristics, injury severity and treatment era may have influenced both selection and outcome. It should not be interpreted as a universal hierarchy of flap types.

Parikh et al. provide a useful counterpoint: among 30 traumatic foot-and-ankle reconstructions with a mean follow-up of 8.5 years, fasciocutaneous flaps more often underwent contour revision than muscle flaps. Their endpoint differs from the secondary deformity and resurfacing outcomes reported by Lin et al. The small, non-randomised cohorts also differed in selection and follow-up. These findings support matching flap composition and contour to the defect; they do not establish a universal advantage for either tissue category [10,11].

Tissue selection should match the defect and preserve function at both sites. Fasciocutaneous tissue can provide a useful skin envelope for later revision, while muscle may be appropriate for dead space or a specific functional reconstruction. Small vessels and limited donor dimensions increase technical demands; experienced microsurgical and anaesthetic teams and reliable postoperative monitoring remain important [2], [10]. The endpoint in a limb includes tendon glide, joint movement, sensation, footwear tolerance and future orthopaedic access. In the head and neck, it includes mastication, speech, swallowing and dentition [1,12]. A surviving flap that repeatedly limits these functions has achieved technical success without demonstrating developmental durability.

Clinical assessment and secondary revision during growth

Clinical review should compare recipient findings with a documented baseline and with the child's current activities. Serial photographs using consistent positioning can show changes in contour or proportion; examination should identify tissue bulk, scar tethering, unstable coverage and restriction around a joint. Goniometry, tendon excursion, strength and gait or task performance help distinguish a supple reconstruction from one that limits function. Footwear tolerance, play, sport, hand use or oral function may reveal restrictions that are missed by inspection alone. Sensory assessment should be appropriate to developmental ability and distinguish protective sensation, altered sensation and pain. Sensory recovery cannot be inferred from flap survival [2,10,11].

Long follow-up is valuable but can remain selective. Alkureishi et al. described 48 reconstructions in 42 children with a median follow-up of 14.9 years. Functional survey findings were reassuring among respondents, but only 16 of 25 contactable patients completed questionnaires. These responses cannot establish equivalence with the general population or exclude morbidity among those not assessed [13].

Potential reasons for secondary intervention include bulk that impairs footwear or movement, a restrictive scar, recurrent contracture, unstable coverage or progressive skeletal and occlusal mismatch. Assessment should identify whether the limitation arises from the transferred tissue, the original injury, nerve dysfunction or the underlying skeleton. Depending on the cause, revision may involve contour adjustment, scar release or resurfacing, combined with rehabilitation or specialist skeletal correction. These are clinical considerations drawn from the synthesis, not validated indications or a universal revision schedule. A planned contour procedure should be distinguished from unplanned surgery for failure or recurrent loss of function [10,11,13].

Vascularised bone and the limits of growth adaptation

The vascularised fibula is an established option for substantial paediatric mandibular defects. Zavala et al. examined functional outcomes in 34 consecutive patients, illustrating the relevance of mouth opening, eating, occlusion and gait alongside reconstruction survival [12]. Living bone can unite and remodel, but a standard diaphyseal segment should not be assumed to reproduce native longitudinal growth.

Zhang et al. reviewed 51 patients reported in 15 articles concerning mandibular growth after fibula reconstruction. Their findings suggest that retained growth depends on factors including the native condyle, age, diagnosis and adjuvant treatment; heterogeneous small reports limit causal interpretation [3]. Earlier observations by Phillips et al. likewise emphasise assessment of the reconstructed mandible within the growing facial skeleton [5]. An increase in overall mandibular dimensions may reflect remaining native growth, apposition or remodelling rather than predictable intrinsic lengthening of the transferred fibula.

Age at reconstruction matters through the amount and pattern of remaining growth. A younger child has a longer period during which the reconstructed and native sides may develop differently, but chronological age alone does not define maturity or predict the eventual discrepancy. The extent and location of resection, pre-existing asymmetry, retained native condyle and ramus, occlusal relationships, soft-tissue restriction and adjuvant radiotherapy can all influence the later facial relationship. Preservation of native growth structures should be considered when compatible with adequate treatment of the underlying disease. The associations in small published series do not justify a universal age window for reconstruction [3,5,14].

Evidence described as growth must also be anatomically localised. In a 2023 longitudinal case report, Yim et al. identified the greatest measured growth at the condyle. This illustrates the need to describe where change occurs; a single patient cannot establish proportional longitudinal growth of a transferred fibular segment [15].

Structurally successful reconstruction can therefore coexist with progressive asymmetry, malocclusion or restricted mouth opening. Follow-up should document facial proportion, occlusal change, dental eruption and temporomandibular function, using imaging to answer a defined clinical question. Orthodontic treatment, dental rehabilitation, distraction or orthognathic correction may become relevant to a particular discrepancy. Timing depends on the functional problem and remaining growth; elective definitive correction may be coordinated with growth completion when function permits. Phillips et al. illustrate the potential need for later orthognathic surgery and the importance of the index construct for subsequent correction. These small observations do not imply that every child requires revision [5,12,14].

Fibula donor morbidity should not be minimised. Du et al. reviewed 16 articles encompassing 294 cases and reported a mean complication incidence of 19.3%, including ankle instability, claw toe and nerve injury [16]. The underlying methods and follow-up were heterogeneous, so this is not a personalised risk estimate or a new pooled result from the present review. Younger age may increase particular risks, but the available evidence does not justify a universal age threshold for safe harvest.

Assessment should include ankle alignment and stability, gait, toe function, sensation and symptoms over time. Preservation of critical donor structures and careful follow-up remain central. Where a vascularised epiphyseal transfer is contemplated, its potential for growth must be weighed against procedure-specific vascular and nerve risks; it should not be conflated with conventional diaphyseal fibula transfer [2,16].

For limb bone reconstruction, union and remodelling also require separate assessment from alignment and length. A 2026 retrospective cohort of 22 children receiving free fibular flaps or pedicled fibular grafts associated ankle valgus with a shorter residual distal fibula. Its small, heterogeneous population limits comparisons between fixation or graft strategies. The findings support attention to donor ankle stability and continued alignment assessment, rather than a universal harvest-length rule [17].

Burn reconstruction and the expanding scar problem

Paediatric burns demonstrate why early healing is not a final outcome. Cubison et al. associated longer healing time with hypertrophic scarring after childhood scalds [18]. In a mixed-age contracture-release series, children required further procedures during growth spurts [19]. These findings concern different stages of recovery: evidence about acute healing should not be presented as direct proof of the long-term superiority of a reconstructive procedure.

Restriction across the neck, axilla, elbow, hand, hip, knee or ankle can affect posture and daily activities. Burn Model System data document clinically important range-of-motion deficits at paediatric hospital discharge, but this endpoint cannot establish the trajectory through puberty or the rate of later recurrence [20]. Facial involvement additionally requires attention to eyelid protection, oral competence and social participation.

Acute care and rehabilitation influence the subsequent reconstructive problem. Wound assessment, appropriate closure, positioning, splinting and therapy should be coordinated to preserve function [21]. In a published meta-analysis of 10 non-randomised studies comprising 532 grafts for paediatric hand burns, Alsaif et al. found lower contracture and subsequent release rates with full-thickness than split-thickness grafts [22]. Differences in burn characteristics, graft selection and follow-up limit causal inference. The finding supports consideration of full-thickness grafting in suitable hand defects, not its routine use for every paediatric burn; donor availability, wound bed and the area requiring coverage remain relevant.

The same graft review reported advantages for split-thickness grafts in some scar, aesthetic and colour assessments [22]. Contracture prevention, appearance and donor cost should therefore be considered separately; improvement in one domain does not guarantee superiority in every outcome.

Flaps may be considered where durable vascularised coverage or additional tissue is required. Tissue expansion offers adjacent skin with useful colour and texture matching but entails staged treatment and risks including infection and exposure. The paediatric head-and-neck literature reviewed by De La Cruz Monroy et al. supports its reconstructive role while showing considerable variation in techniques and reporting [23]. Family capacity to attend appointments and tolerate the expansion period is part of selection.

Nonoperative scar management and rehabilitation remain adjuncts to reconstruction. Parry et al. associated earlier scar interventions with improvements in some scar parameters after paediatric facial grafting but did not demonstrate a relationship between intervention timing and subsequent facial reconstructive surgery [24]. Exercise research supports attention to strength after major childhood burns, while patient-

oriented recovery studies show why physical healing alone cannot capture recovery [25,26]. A fixed contracture requires assessment of its structural cause, and recurrent restriction during growth warrants renewed multidisciplinary review.

Craniofacial and trunk reconstruction

Craniofacial planning must integrate skeletal development with airway, vision, dentition and facial function. Treatment should be coordinated across the specialties relevant to the child's condition, with secondary procedures anticipated when needed to address subsequent growth [6]. Predictable staged treatment should be distinguished from unplanned revision for a complication, because combining these events obscures the burden and effectiveness of care.

Chest-wall and breast development create further timing considerations, particularly during puberty [27]. For structural chest defects, stability, soft-tissue coverage and subsequent development must all be considered. Custom titanium reconstruction has been described in a two-patient paediatric technical report, demonstrating feasibility in selected cases rather than proving growth compatibility to maturity [28]. Implant geometry and stability at implantation cannot be assumed to predict long-term performance. Decisions about rigid reconstruction should remain individualised, with explicit plans to reassess symptoms, contour and function as the child grows. Evidence from adult chest-wall series should not be used as direct proof of paediatric growth outcomes.

Donor sites and preservation of future options

The donor site is part of the long-term reconstructive outcome. Functional deficits may become apparent as activity demands increase, and a scar or contour change may acquire greater importance to the child in adolescence. Fibula-harvest evidence particularly supports follow-up beyond early wound healing, including alignment, mobility and neurological symptoms [16]. More broadly, donor selection should consider the tissue required, likely functional cost and preservation of future reconstructive options [8].

The reconstructive ladder remains a useful description of technical options, but escalating complexity does not necessarily track lifetime treatment burden [29]. A straightforward initial closure may lead to repeated revision, whereas a more complex reconstruction may supply tissue that is easier to adapt later. This is a clinical decision framework rather than a demonstrated comparative advantage. Present function, anticipated growth, donor cost and the feasibility of secondary procedures should be considered together, with uncertainty made explicit.

Measuring developmental durability

Outcome reporting should distinguish viability from anatomical durability, growth compatibility, function, donor-site morbidity and treatment burden. Early composite assessments are informative, but locally developed scores require external validation before routine use or comparison between centres [4]. The proposed concept of developmental durability should therefore be reported through its individual domains rather than assigned an unvalidated numerical total.

Table 1 translates these domains into suggested clinical observations and developmental review points. Measurements should be selected for the defect and the child's ability to participate, recorded consistently over time and interpreted separately. The table is an author-developed clinical framework, and it has no validated total score, thresholds or mandatory follow-up intervals.

Assessment domain	Suggested clinical measurements	Developmental review points
Tissue integrity and proportion	Wound stability, ulceration, scar tethering, contour and bulk; photographs with consistent positioning and relevant serial dimensions.	After healing and contour stabilisation; renewed review with growth spurts, symptoms or changes in body proportion.
Skeletal development	Limb alignment and length where relevant; facial symmetry, occlusion, dental eruption, mouth opening and temporomandibular function.	During skeletal growth and dental transitions; puberty and skeletal maturity; imaging for a defined clinical question.
Movement and functional adaptation	Joint range by goniometry, tendon glide, strength, gait, hand tasks, footwear tolerance; swallowing, mastication or speech as relevant.	After rehabilitation and with increased loading, school activities or sport; reassess any loss of previously achieved function.
Sensation and pain	Developmentally suitable sensory examination; protective sensation, pain, dysaesthesia and tolerance of daily use.	As reliable participation becomes possible and activity demands increase; reassess new symptoms or recurrent skin injury.
Donor development and function	Donor-specific examination; fibula donors require ankle alignment and stability, gait, toe function and sensory assessment.	Beyond donor wound healing; growth spurts, increasing activity, puberty and maturity, adapted to donor risk.
Child and family experience	Age- and condition-appropriate patient-reported outcomes; pain, appearance concerns, participation and school impact. Record child and parent-proxy reports separately.	When self-report becomes feasible; changing school or social demands, adolescence and transfer to adult services.
Cumulative treatment burden	Number and purpose of procedures, admissions and therapy episodes; identify planned stages, contour refinements, failure and recurrent functional loss separately.	At each intervention and developmental review; summarise at skeletal maturity and transition to adult care.

TABLE 1: Suggested assessment domains and developmental milestones for developmental durability

This is an author-developed synthesis informed by the cited clinical and outcome-measure literature [3,5,10,11,13,16,17,20,30-32]. These are suggested domains and review opportunities, not a validated composite instrument or a fixed surveillance protocol. Formal outcome measures require age-, language- and condition-appropriate selection.

Patient-reported outcome measures should match the child’s age, language and condition. The Pediatric Quality of Life Inventory (PedsQL) provides a framework for health-related quality-of-life assessment [30]; however, evidence of instrument validity in one population does not automatically establish validity across paediatric plastic surgery [31]. The original Patient-Reported Outcomes Measurement Information System (PROMIS) paediatric development programme included self-reported health domains in children aged 8-17 years [32]. Selection of a current PROMIS form should follow the validation and respondent requirements for that specific form. A study in another disease group alone cannot establish validity for reconstructive outcomes.

Scar assessment can incorporate the Patient and Observer Scar Assessment Scale (POSAS), as described in its original development report [33]. Its patient component should be used only when developmentally appropriate, and observer assessment should not be treated as interchangeable with the child’s report. Likewise, parent-proxy and child self-report should be identified separately. Pain, appearance concerns, school and activity participation, and the purpose and number of further procedures add information that flap survival cannot capture [26,31].

Limitations of the evidence

Much of the directly relevant reconstructive evidence consists of retrospective specialist-centre series. Referral patterns, operator experience and the selection of patients suitable for microsurgery limit generalisability [8,10,12]. Comparisons are vulnerable to confounding by indication: larger, contaminated or more complex defects may receive different tissues and have worse outcomes regardless of the reconstruction. Changes in practice across long recruitment periods further complicate interpretation.

Growth is variably assessed, and follow-up described as long term may still end before skeletal maturity. Inconsistent definitions of failure, revision and donor morbidity make comparisons difficult [3,16]. Loss to follow-up and selective reporting may obscure late functional deficits or treatment fatigue. These concerns are not resolved simply by combining observational reports in a published meta-analysis.

This review also has methodological limitations. Targeted retrieval, English-language restriction, selective source inclusion and incomplete full-text access introduce selection, language and availability bias. The focused update and final cited-source count improve transparency but do not recover the original screening history or establish that all relevant literature has been captured. There was no exhaustive screening, independent duplicate extraction, formal risk-of-bias assessment or certainty grading. The synthesis cannot establish comparative effectiveness, calculate a universal complication rate or prescribe one flap or timing strategy for every child.

Implications for practice and research

Table 2 summarises the anatomical implications of this synthesis. The clinical emphasis differs by region: craniofacial reconstruction requires attention to occlusion and facial proportion, limb reconstruction to loading and movement, burns to recurrent restriction, and trunk reconstruction to chest and breast development. These considerations derive mainly from observational evidence and should support individual assessment rather than prescribe a common operative pathway.

Region	Growth-related risks	Functional outcomes to record	Surveillance and evidence limits
Craniofacial and mandibular	Facial asymmetry, malocclusion, altered dental eruption, restricted mouth opening and mismatch between native and transferred tissues.	Occlusion, mastication, speech, swallowing, airway where relevant, mouth opening, dental rehabilitation and facial proportion.	Review during dental transitions and growth spurts, at puberty and maturity. Growth estimates rely on small heterogeneous series and case reports [3-5,12,15].
Limb soft tissue and bone	Bulk or scar restriction, footwear difficulty, joint stiffness, skeletal malalignment or length discrepancy; donor ankle or toe dysfunction.	Joint range, tendon glide, sensation, gait, loading, footwear and activity tolerance; union and alignment for osseous constructs.	Reassess after rehabilitation, as loading increases and throughout growth. Flap comparisons are non-randomised and use different revision endpoints [10,11,15-17]
Burns	Scar restriction, recurrent contracture and loss of previously achieved joint or facial function as the child grows.	Range of motion, hand use, posture, oral competence or eyelid function as relevant; pain, scar symptoms and participation.	Review after healing and rehabilitation, with growth spurts and recurrent restriction. Graft comparisons are observational; discharge deficits do not establish later recurrence [18-22]
Trunk, chest wall and breast	Scar restriction, chest-wall asymmetry, mismatch with a rigid construct and altered breast development during puberty.	Coverage, stability, respiratory symptoms, posture, contour, breast symmetry and participation as appropriate.	Reassess during growth and puberty and for implant-related symptoms. Custom titanium evidence includes a two-patient report, without proof of general growth compatibility [27,28].

TABLE 2: Growth-related considerations across anatomical regions

Author-developed summary of the cited literature. Surveillance should reflect the specific defect, reconstruction and developmental stage. Review points are clinical suggestions, not evidence-based fixed intervals; no tissue or implant is assumed to maintain proportional growth.

Before surgery, assessment should define the time-sensitive functional problem and document baseline recipient and donor findings. Relevant measures may include joint movement, alignment, sensation, occlusion, photographs and age-appropriate patient-reported outcomes. The proposed reconstruction should be discussed in terms of anticipated function during growth, plausible secondary procedures and preservation of future options. This represents a practical application of the narrative synthesis, not a validated treatment algorithm.

After surgery, surveillance should respond to developmental transitions and symptoms, including growth spurts, puberty, changing activity demands and dental maturation. There is insufficient evidence to prescribe a single follow-up interval for all defects. Families should understand which changes merit earlier reassessment and how care will continue when paediatric services end.

Registries offer a means to study uncommon reconstructive indications when randomised comparisons are impractical [34]. Guidance on international paediatric registry development supports coordinated governance and consistent data collection, although registry design alone does not establish treatment effectiveness [35]. A useful reconstructive dataset would record age and maturity, diagnosis and defect extent, tissue transferred, relevant adjuvant treatment, recipient and donor function, and validated patient-reported outcomes. Planned stages should be distinguished from unplanned revision, with reasons for loss to follow-up recorded. Follow-up to skeletal maturity and appropriate adjustment for case mix are priorities for evaluating developmental durability.

Conclusions

Paediatric reconstruction is a longitudinal intervention whose success must be assessed during growth. Technical survival is an essential early outcome, but it does not establish sustained function, acceptable proportion or freedom from donor-site problems. Soft-tissue accommodation and bone remodelling should not be equated with predictable native growth. Scars, grafts and donor sites that initially appear satisfactory may become limiting as the child matures. Developmental durability provides a useful organising concept for planning and assessment, but it remains to be validated and should not be presented as a composite score. Current evidence supports individualised multidisciplinary planning, explicit discussion of uncertainty and surveillance through relevant developmental transitions. Future research should prioritise standardised long-term measurement of function, growth, donor morbidity, revision burden and the child's experience of treatment.

Appendices

Literature identification and selection details

Appendix 1: Scope Interfaces and Search Date

The record below documents the focused update performed on 20 October 2026. The original literature identification was purposive, and a complete original retrieval and screening log was unavailable. The update therefore improves the traceability of specific searches without retrospectively converting the review into a systematic review or a prospectively registered protocol.

PubMed was queried through the National Center for Biotechnology Information Entrez E-utilities API. ESearch identified PubMed records; EFetch retrieved the corresponding bibliographic records and abstracts in XML. PubMed Central and original publisher pages supplied accessible full texts. Reference tracing and targeted title, author and DOI checks supplemented the indexed searches. Comprehensive Embase or Scopus searching was not performed.

The ESearch interface was <https://eutils.ncbi.nlm.nih.gov/entrez/eutils/esearch.fcgi> and the EFetch interface was <https://eutils.ncbi.nlm.nih.gov/entrez/eutils/efetch.fcgi>. Both recorded ESearch requests specified db=pubmed, retmode=json, sort=relevance and retmax=100; EFetch used db=pubmed and retmode=xml. Human, age and English-language requirements were applied during source selection, rather than as additional database filters in these two queries.

Appendix 2: Exact Search Strings Used in the Focused Update

Query 1 Microsurgery growth and donor morbidity

```
(child*[Title/Abstract] OR pediatric*[Title/Abstract] OR paediatric*[Title/Abstract] OR adolescent*[Title/Abstract])
AND ("free flap"[Title/Abstract] OR "free flaps"[Title/Abstract] OR "free tissue transfer"[Title/Abstract] OR
"vascularized fibula"[Title/Abstract] OR "vascularised fibula"[Title/Abstract])
AND (growth[Title/Abstract] OR "long-term"[Title/Abstract] OR revision[Title/Abstract] OR "donor-site"
[Title/Abstract])
AND ("1900/01/01"[Date - Publication] : "2026/10/20"[Date - Publication])
```

The first query used a broad historical date range ending on the update date. No minimum follow-up duration or attainment of skeletal maturity was imposed as a search restriction. Such features affected clinical interpretation and source prioritisation.

Query 2 Paediatric burn grafting and contracture update

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(pediatric[Title/Abstract] OR paediatric[Title/Abstract] OR child*[Title/Abstract])
AND ("burn contracture"[Title/Abstract] OR "hand burns"[Title/Abstract])
AND (graft*[Title/Abstract] OR growth[Title/Abstract] OR recurrence[Title/Abstract])
AND ("2023/01/01"[Date - Publication] : "2026/10/20"[Date - Publication])
```

The second query was a recent-literature update covering 1 January 2023 through 20 October 2026; earlier foundational burn sources were retained through the original retrieval and reference tracing.

Appendix 3: Recorded Returns and Retrieval Limits

Search	PubMed matches	Records retrieved	Publication-date bounds
Query 1 Microsurgery	295	100	1 January 1900 to 20 October 2026
Query 2 Burns	11	11	1 January 2023 to 20 October 2026

TABLE 3: Appendix Table: Recorded results of the focused PubMed update

For Query 1, the first 100 records returned by the request were retrieved for focused relevance checking; the remaining matches were not exhaustively screened. All 11 records returned by Query 2 were retrieved. Counts reflect the recorded responses on 20 October 2026 and may change with subsequent indexing. They are query-level returns, not a deduplicated screening flow or the total number of studies assessed for the whole review.

The 35 cited publications came from the combined purposive retrieval, reference tracing, targeted source checks and focused update. They are not presented as 35 studies selected from the sum of the two query returns. Published reviews may overlap with primary cohorts; no aggregate patient or flap total was calculated across these sources.

Appdendix 4: Operational Source Selection Rules

Clinical population: Retain clinical evidence concerning patients aged 18 years or younger. For mixed-age reports, use identifiable paediatric results or an explicit paediatric observation, with the mixed-age status stated. Do not treat an adult-only clinical rate as a paediatric outcome estimate.

Reconstructive scope: Retain reconstruction of congenital, traumatic, oncological or burn-related craniofacial, limb or trunk defects, including recipient-site and donor-site consequences. Exclude unrelated operations, purely cosmetic procedures and isolated dental treatment without a reconstructive indication.

Clinical outcomes: Require at least one relevant endpoint: flap or graft viability, growth or proportion, function, donor morbidity, late complications, secondary procedures, scar restriction or patient-reported recovery. Technical reports can inform feasibility, but early survival or wound healing alone cannot establish developmental durability.

Follow-up: Do not impose a common minimum duration across disparate indications. Give greater weight to serial measurements, explicitly stated follow-up and observation across a developmental transition. Identify whether skeletal maturity was reached; do not assume that an author-defined long-term endpoint includes maturity.

Reviews and contextual sources: Retain reviews directly relevant to the reconstructive question, original outcome-instrument reports and registry-methodology publications when they support a specific interpretation. These are separate source classes, not additional paediatric clinical cohorts. Generic or adult instrument development does not establish validity in paediatric reconstruction.

Language, evidence type and access: Use English-language peer-reviewed sources. Exclude animal and laboratory studies and conference-only reports from definitive clinical recommendations. Where only an indexed abstract is available, use only verifiable information and avoid recommendations that require inaccessible full-text detail.

Overlapping publications: Treat publications, patients, flaps, grafts and procedures as different units. Interpret a published review alongside its component studies without counting overlapping participants again or calculating a new overall complication rate.

These rules document source selection and interpretation for the narrative revision; they were not prospectively registered eligibility criteria and do not imply exhaustive or independently duplicated screening.

Appendix 5: Prioritisation and Conflicting Findings

Directly relevant longitudinal clinical reports with serial growth or functional assessment received greater interpretive weight for developmental questions than reports limited to technical survival. Clearly defined populations, denominators and follow-up improved interpretability. Recent cohorts were considered alongside foundational reports; larger series informed feasibility and complication patterns, whereas small

mechanistic reports could illustrate a specific growth issue without establishing its frequency.

Conflicting findings were examined for differences in anatomical region, defect severity, flap composition, treatment era, adjuvant therapy, endpoint, follow-up and attrition. For example, contour adjustment and recurrent deformity were interpreted as different outcomes. Findings were retained with their limitations rather than resolved by counting studies favouring a technique. No formal risk-of-bias tool or certainty-grading framework was applied.

Appendix 6: Numerical Interpretation and Retained Source Count

The synthesis contains 35 cited publications across the clinical, review and methodological source classes. The number of records initially considered for the original narrative search cannot be reliably reconstructed. Numerical findings are descriptive quotations or summaries of their original reports, with source-specific units and follow-up denominators preserved. No new pooled incidence, effect estimate, confidence interval, subgroup test, meta-regression or statistical hypothesis test was generated.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Drafting of the manuscript: Daniel Gravino, Matthias Pellicano

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