Reconstruction of Clival Defects using Vascularized Free and Pedicled Flaps: Systematic Review and Proposed Algorithms

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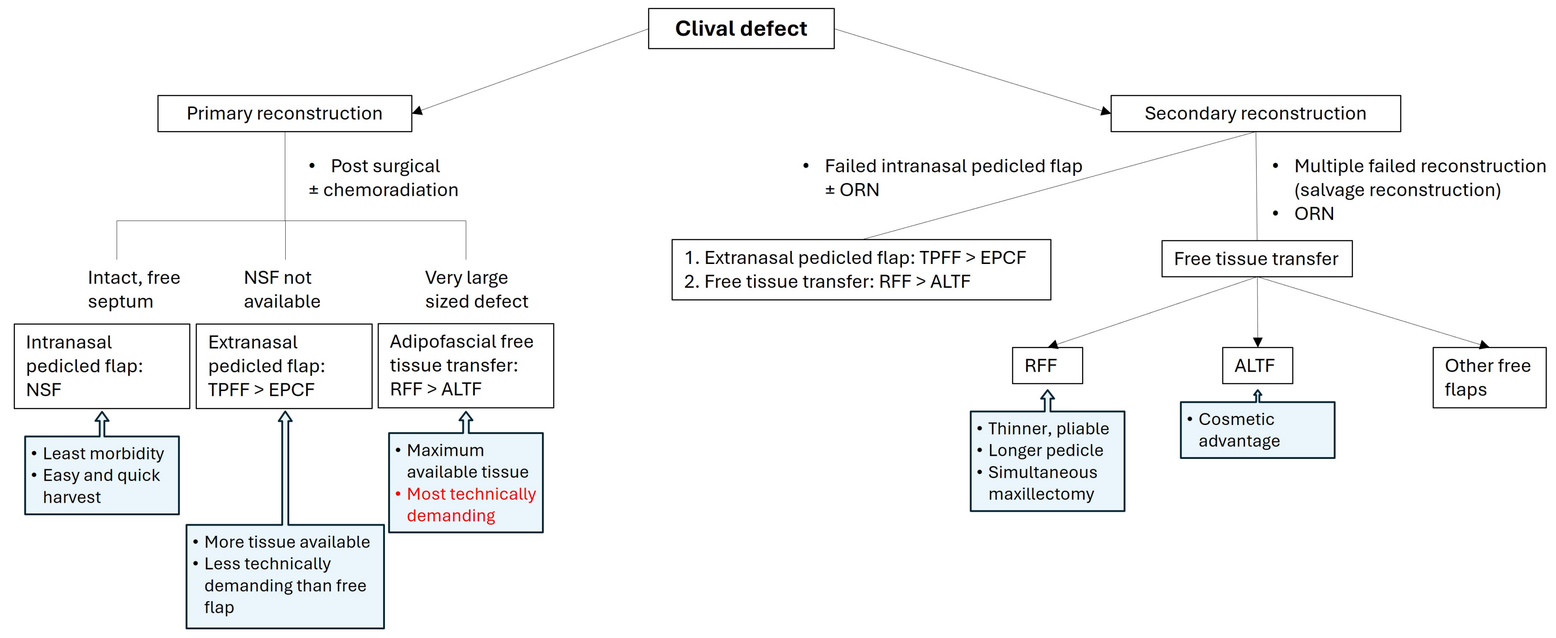
INTRODUCTION

- Clival defects pose unique challenges for reconstruction: High-volume, high-pressure CSF leaks from the prepontine subarachnoid cistern, herniation of the pons and retroclival structures, dynamic palatal and pharyngeal movements, making the reconstructive assembly prone to dislocation, and gravity-dependent nature of the reconstructive site[1].
- Endonasal flaps may not always be available, or be inadequate for large defects, and additional vascularized pedicled flaps and free tissue transfer may be necessary.
- There is a lack of a systematic approach to using these extranasal flaps in the existing literature.

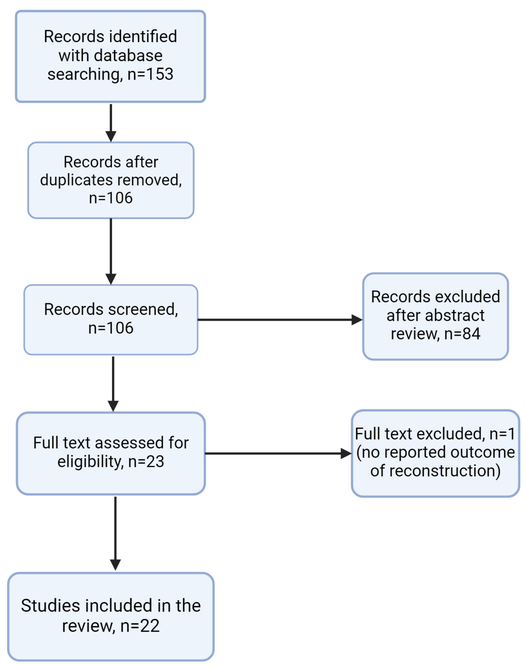
FIGURE 2: A suggested simplified algorithm for the reconstruction of clival defects based on the results of this review.



METHODS

- The following databases were searched with an initial search conducted in July 2024: Ovid Medline (1946 to present), Ovid Embase (1988 to present), Scopus (2004 to present), and Web of Science (1975 to present). MeSH (Medical Subject Headings) terms included: Cranial Fossa, Posterior; Free Tissue Flaps; Surgical Flaps. Keywords used included: clivus; clival defect*; reconstruct*; and free flap* (* indicates truncation of the word or phrase).
- Studies reporting results of using vascularized pedicled or free flaps in reconstructing clival defects were selected for review. Studies based only on cadaveric dissection were excluded.
- Successful reconstruction was reported as flap survival and restoration of an air-tight seal (absence of CSF leak or pneumocephalus).

FIGURE 1: PRISMA analysis



RESULTS

- The literature search results and subsequent screenings are shown in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram (Figure 1)
- All the studies included were of level 4 evidence.
- **Clival reconstruction using pedicled flaps[1-11,22]:**
  - Successful reconstruction was reported in 57/67 patients (85.1%), median follow-up of 9 months (IQR 4-13).
  - 7/11 (63.6%) patients had successful reconstruction after a failed primary reconstruction
  - Mostly used in primary clival reconstruction post-resection of clival tumors
  - Nasoseptal flap (NSF) was the most frequently used, and successful in 29/34 (85.3%)
  - Temporoparietal fascia flap (TPFF) was the most successful extranasal pedicled flap; no failure reported in 13 patients.
  - Extracranial pericranial flap (EPCF) use was reported in 1 study; 3/7 (43.9%) patients failed repair and 4/7 (57.1%) developed frontal sinusitis.
  - Inferior turbinate flap, middle turbinate flap, nasal floor flap, and palatal flap use was reported in few patients.
- **Clival reconstruction with vascularized free flaps[12-22]:**
  - Successful reconstruction in 17/18 patients, median follow-up of 24 months (IQR: 4-37)
  - No follow-up reported in the remaining 1 patient
  - 12/18 patients had clival osteoradionecrosis (ORN), 12/18 patients underwent salvage reconstruction after multiple failed repairs.
  - Radial forearm flap (9) and anterolateral thigh flap (8) were most used.
  - Facial vessels were preferred for microvascular anastomosis
  - Pedicle transposition was performed via transmaxillary > parapharyngeal > retropharyngeal routes.
  - 1 vasculitis patient with cervical spine osteomyelitis underwent successful repair with anterior serratus muscle flap.

DISCUSSION

- Encouraging success rate of ~88% for clival reconstruction in 85 patients, even after the unfavorable anatomy.
- Intranasal mucosal pedicled flaps first choice for endoscopic skull base repair, with NSF being the workhorse flap.
- Alternative intranasal pedicled flaps can be used when the NSF is unavailable but are associated with an increased difficulty of harvest, smaller size, and lesser arc of rotation[23].
- TPFF and EPCF associated with a robust blood supply and larger flap area but have higher morbidity of harvest and need a longer transposition route[23].
- TPFF is the preferred flap for lateral and posterior skull base reconstruction and could be the flap of choice when NSF is unavailable[23].
- Use of free flaps primarily restricted to large defects, salvage reconstruction, and/or poor vascularity of the wound bed, as in ORN[12,13].
- Advantages include large available tissue volume and robust vascularity; however, they are associated with increased reconstruction complexity, longer operative times, and higher surgical costs[24].
- Specific challenges like bulky free flap compressing the brainstem, and upper aerodigestive tract obstruction requiring tracheostomy and alternative feeding routes like a percutaneous gastrostomy are possible[12].
- Transmaxillary route has least morbid pedicle transposition but longest transposition route[12].
- Retropharyngeal and parapharyngeal transpositions directly approach the recipient vessels in the neck with least tissue dissection, hence, requiring smaller vascular pedicles. However, they need separate cervical incisions for microvascular anastomosis and carry a risk of postoperative abscess formation[12].
- RFF is thin and pliable with a longer pedicle but has increased donor site morbidity[25]. ALTF can include a portion of vastus lateralis muscle, helpful for wound healing and adherence[26].
- Sparing the skin paddle and using only the adipofascial part of the free flap can decrease the donor site morbidity[13].

CONCLUSIONS

- Good reconstructive outcomes are reported using both pedicled and free flaps.
- Intranasal mucosal pedicled flaps, followed by extranasal pedicled flaps, followed by free flaps formulate the ascending reconstructive ladder for clival defect reconstruction, as mentioned in the proposed algorithm (Figure 2).
- Choice of flap is determined by the previous surgical history, radiotherapy, wound vascularity, defect size, health of the surrounding nasal mucosa, simultaneous clival surgery (if any), and the preferred pedicle transposition route (for free flaps)

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