INTRODUCTION
Reconstruction of skull base defects has been a major challenge in development of endoscopic approaches (EEA) to the skull base. The goals of reconstruction of endoscopic skull base defects, therefore, are similar to open entities but extended to include pressure sores, elimination of dead space, and protection of neurovascular structures.

Reconstruction of small dural defects is independent of which technique is used, and vascularized tissue does not appear to be critical. In contrast, large dural defects have been traditionally repaired using regional vascularized flaps, which promote healing and diminish complications. Recently, novel regional vascularized flaps that do not require cutaneous incisions have been designated nasoceleatal (NS) flap, posterior pedicled inferior turbinite (IT) flap, and pedicled palatal flap. The development of the NS flap has partially overcome the challenge of obtaining vascularized tissue to cover large defects after EEA. However, these flaps cannot be used in patients who have undergone previous posterior septotomies, wide sphenoidectomies, or have tumor involvement of the septum. In an attempt to use new sources of vascular supply and to keep pace with rapidly expanding reconstructive requirements, we investigated the anatomical foundations for novel modifications of the occipital galeopericranial (OGP) flap for reconstruction of skull base defects.

MATERIALS AND METHODS
Two fresh and four preserved human specimens were used for anatomic dissections. All specimens received arterial injections with red (arterial system) and blue (venous system) silicone. Using cadaver dissections and measurements, we investigated the feasibility of transposing pedicled occipital galeopericranial flaps into the nasal cavity and anterior skull base. Different techniques for transposition into the nasal cavity were investigated. Flexible surgical rulers (Kendall, Coviden, Mansfield, MA, USA) and rigid rulers (Wescott, Bankstown, Australia) were used for measurements to support our investigation.

TECHNIQUE
Flap harvesting:
In brief, a transverse incision is made from the occipital scalp along the tip of the mastoid process, which is continued anteriorly and inferiorly for 4-5 cm along the anterior border of the sternocleidomastoid muscle. The attachments of the sternocleidomastoid (SCM), splenius capitis (SC) and longissimus capitis (LC) muscles are transected, which exposes the pedicle. Dissection of the pedicle can be started in the neck and then followed supero/posteriorly, or at the transverse segment of the vessel and then followed both anteroinferiorly, and poste/superiorly. Two occipital skin flaps are raised in the subcutaneous (supragaleal) plane exposing the galea (Fig 2A). Centered on the pedicle, the galeoperiostum is incised (2 vertical and 1 transverse incisions) up to the vertex, demarcating the dimensions of the flap (Fig 2B). The flap is elevated subperiosteally from the vertex (caudal direction). Strong fibrous attachments are encountered at the superior nuchal line (SNL). Muscular fibers and insertions are transected at, and inferior to the SNL, attempting to preserve as much insertion of the trapezius muscle as possible. A large occipital emissary vein is encountered and should be left in close proximity to the bone to avoid injury to the pedicle. The pedicle is finally dissected proximally completing flap harvesting. (Figure 3)

Creation of parapharyngeal/transpyoid (delivery) corridor: The posterior belly of the digastric muscle (PDM) is dissected free and mobilized towards the angle of the mandible (Fig 4). Alternatively, the PDM can be displaced inferiorly or superiorly. A blunt clamp is used to create a tunnel within the parapharyngeal fat, in an anterior, superior and medial direction towards the infero lateral aspect of the pygoideal plates/ maxillary tuberosity (which can be palpated with the finger), along the infero-medial surface of the medial pterygoid muscle to avoid the pterygoideal venous plexus. Transillumination (endoscopic tip anterior to the level of the torus tubarius) from the nasal cavity can help guide the final portion of the dissection and define the entry point of the corridor into the nasal cavity. Alternatively, the creation of this tunnel can be assisted endoscopically to allow better visualization of vascular structures. A standard ipsilateral wide maxillary antrostomy and posterior maxillary maxilllectomy is performed with standard endoscopic sinus instrumentation. The medial aspect of the posterior maxillary wall is resected with Kerrison rongeurs (Fig 5A). The sphenopalatine artery and other branches of the internal maxillary artery in the pterygoideal plate are ligated. A ligature is used to remove the inferior aspect of the pterygoideal plates opening the corridor to the naso cavity (Fig 5B). This soft tissue tunnel should allow passage of at least a finger without significant resistance to guarantee enough space for the transposition of the bulky proximal portion of the flap. We found this critical to avoid trapping of the flap in the corridor. Lastly the flap is delivered into the nasal cavity. (Fig 6)

RESULTS
The OGP flap was transposed into the nasal cavity and provided complete coverage of the entire anterior skull base in all specimens. We found that if the flap was harvested up to the vertex, it was long enough to even extrude its most distal portion resulting from a standard endoscopic anterior craniofacial resection, however, flaps up to 44 cm2 (11 cm long x 4 cm wide) were harvested. The occipital artery was always visualized in intimate relation with one or two veins (running along or looping around the artery).

DISCUSSION
Regional (extranasal) flaps that can be used for reconstruction of ventral skull base defects include the transpyoid flaps, a temporoparietal fascia (TP) flap, and an anterior based pericranial flap. The TP flap requires cutaneous incisions and a skilled surgeon to perform the dissection and transposition. An extranasal pericranial flap passed through an osteotomy at the level of the nasion is an additional option but requires more extensive sinus surgery and is best suited for anterior cranial base defects.

CONCLUSIONS
In selected patients, the parapharyngeal and transpyoid transposition of a pedicled occipital galeopericranial flap is a suitable option for vascularized reconstruction of ventral skull base defects.

REFERENCES
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ANATOMY
The occipital artery (OA) is the 5th artery of the external carotid system and the main vessel supplying the posterior scalp. Its long trajectory provides the possibility of harvesting it as a true vascular pedicle. Three segments can be identified from its origin until its terminal branches: (1) oblique ascending lateral segment, (2) transverse segment, and (3) oblique ascending (vertical) medial segment. In a study of 50 cadavers, the OA and occipital vein mean diameters were reported to be 3.7 mm and 3.5 mm respectively. The mean occipital artery length (from origin to superficialization point in galea) is 134.6 mm. Venous drainage of the occipital scalp is via an occipital vein (OV), which travels with the artery through the neck. Sometimes, two veins or a plexus run along with the artery. A large tributary vein has been reported at the mastoid tip joining the transverse venous segment, which has to be carefully ligated to avoid injury to the pedicle.

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