Abstract

Endoscopic approaches to treat anterior cranial fossa pathology and aneurysms often require proximal vascular control of the cavernous carotid artery (CavCa)

Adaptable exposure of this artery carries risk due to:
1. Encasement in bone
2. Pathway through the proximal and distal dural ring
3. Proximity to cranial nerves in the cavernous sinus

Using a cadaver model with microfil injected arteries as well as an actively bleeding CavCa, we demonstrate the advantages and ergonomic considerations for using the dual endoscopic endonasal and precaruncular approaches for clipping the CavCa

Simulated training with these techniques and the dual approach enhance surgical skill sets and improve appreciation of intraoperative anatomy for trainees

Introduction

Endoscopic endonasal approaches for sellar, parasellar, cavernous sinuses, middle fossa and petrous apex pathology and aneurysm clipping have increased significantly [1]. The increased application of the expanded endoscopic endonasal approach places the CavCa at increased risk of injury during the resection of the pathology that affects these regions. Highly vascular, large, calcified lesions that obstruct visualization of the normal anatomic landmarks can limit the extent of resection and lead to poor visualization of the carotid artery subjected to injury. Limitations of expanded endoscopic approaches show the potential advantage for a dual port approach that may be used to access these lesions and improve visualization.

In this project we demonstrate:
1. Benefits of a dual port approach for clipping the cavernous carotid artery
2. Feasibility of simulation set-up and cost effectiveness
3. Potential benefit of pre operative team simulation and approach planning
4. Improved degrees of freedom and visualization using the fourhanded technique

Methods and Materials

Five adult cadaveric heads were used and prepared according to the OHSU Body Donation Program Protocols

Red microfil was injected into the bilateral carotid arteries and vertebral arteries to enhance vessel visibility

Figure 1: An active simulation of CavCa bleeding

Transphenoidal dissection:
1. The head was placed supine on a head holder
2. After exposure of the sphenoid sinus, a sphenoidotomy was performed
3. The bony anatomy overlaying the critical structures were identified
4. The structures in the regions of the sella, supra sellar cavernous sinus and clivus were exposed. The bone overlying the CavCa was removed. The proximal dural ring was divided. The CavCa was exposed

Precaruncular dissection [2]:
1. An incision was made medial to the caruncle and widened along the canthal tendon
2. A port was created in the lamina papyracea using the fronto-ethmoidal suture and ethmoidal arteries as landmarks
3. The CavCa, pituitary gland, and sella were readily visualized

The precaruncular port for the endoscope and transphenoidal port for instrumentation allowed clipping of the CavCa at multiple sites using an adjustable clip with clip applicator

Results

Dual port technique improved the working degrees of freedom of the instruments by removing the endoscope from the endonasal port

Dual port technique provided better visualization of the tip of the clip and its relationship to adjacent critical structures

Use of an adjustable clip applicator minimized the translation of torque to the CavCa in both the application, re-positioning, and removal of the clip

The transorbital port provides excellent visualization of the central skull base

Discussion

CavCA aneurysms, in addition to iatrogenic causes, have been associated with fungal infections and chemotherapy treatment [3,4]. These aneurysms and pseudaneurysms are traditionally treated with endovascular techniques [5]. When endovascular techniques are not sufficient, neurosurgical clipping must be performed [6]. In addition, there is a growing body of literature on expanded endonasal approaches to clipping of aneurysms.

We highlight a feasible, cost-effective, and replicable cadaveric simulation model for clipping the CavCa and gaining access to bilateral CavCa, sellar, parasellar, medial and lateral cavernous sinus, and clivus.

This dual port technique facilitates a fourhanded microsurgical dissection, improved visualization, and enhanced functional working area. The benefits for neurosurgical and otolaryngology residents is apparent in that skill sets can be learned and improved upon in a safe environment without jeopardizing patient care [7].

Conclusions

Simulation offers a valuable training experience for faculty and residents

Cadaver models, in particular, enhance the appreciation of intraoperative anatomy and allow trainees to practice challenging approaches and techniques for managing vascular injury endoscopically

Simulated training allows trainees to develop an effective algorithm for obtaining proximal CavCa control and management of highly vascular skull base lesions, and/or a bleeding CavCa

This particular model is cost-effective and allows trainees and surgical teams to rehearse techniques multiple times and simulate the operative challenges

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