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Case report

The use of image guidance in avoiding vascular injury during trans-sphenoidal access and decompression of recurrent pituitary adenomas

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ABSTRACT

Repeat trans-sphenoidal surgery for pituitary adenomas is fraught with the risk of injury to the internal carotid artery that can occur either while incising scar tissue in the sphenoid sinus/sella or during tumour decompression. The ensuing complications can be devastating and difficult to manage within the limited confines of the bony sella and sphenoid sinus, and more so when the local anatomy is distorted by previous surgery. This article highlights complications involved in repeat trans-sphenoidal pituitary surgery and outlines the role of image-guided surgery in avoiding them. With the use of modalities like Doppler sonography and neuronavigation, the position of the ICA can be determined accurately in all cases.

1. Introduction

The position of the carotid arteries is a primary concern for the pituitary surgeon. Identification of the interface of the sella and cavernous sinus dura is known to be unreliable (Dusick et al., 2007), and hence not helpful in this regard. The position of the carotid arteries in the carotid sulcus, on either side of the sella floor in the sphenoid sinus, is visualized well during endoscopic pituitary surgery, but is difficult to recognize during repeat microsurgical trans-sphenoidal tumour excision. This procedure carries a higher risk of carotid injury and its sequelae including fatal bleeding and the formation of a pseudo-aneurysm or a carotico-cavernous fistula (Yamasaki et al., 2002; Dusick et al., 2007).

In a retrospective review of 98 patients operated on for recurrent pituitary adenomas without image guidance, we identified 1 case (1%) of cavernous internal carotid artery (ICA) injury. The mishap had occurred at the time of dural opening, and was controlled by packing with a layer of muscle and fat, reinforced by a tissue sealant (Bioglue® CryoLife Inc, Atlanta, GA). A subsequent digital subtraction angiogram showed occlusion of the left cavernous ICA, with good collateral flow into the supraclinoid ICA across the posterior communicating artery. This case provided the impetus to assess the use of image-guidance systems in re-exploratory trans-sphenoidal surgery. Based on our findings in 26 such subsequent cases, we recommend the usage of colour Doppler or neuronavigation notwithstanding the additional operative time or costs.

2. Case reports

2.1. Case 1

Fig. 1a illustrates the case of a 31 year-old male who had undergone 2 previous trans-sphenoidal surgeries for a non-functioning pituitary adenoma. The previous site of entry was close to the internal carotid artery (ICA) on the left side (Fig. 1b), and the cavernous intercarotid distance was 1.7 cm. The sphenoid sinus and sella had been packed with fat, further concealing the previous site of entry. We introduced a 10 MHz (3 mm diameter) Nicolet Companion Micro transducer (Nicolet Biomedical Inc., Madison, WI) into the saline-filled sphenoid sinus to locate the position of the left ICA (Fig. 2a). The autogain function of the Doppler sonogram was switched off to facilitate identification of the correct depth and site of the artery. The probe was held using a sterile rubber-band between the cups of a pair of biopsy forceps. A flow velocity of 40–45 cm/s was recorded (Fig. 2b) at a depth range of 3–5 mm, indicating the site of the left ICA. This guided us to a more medial portal of entry into the sella.

2.2. Case 2

Fig. 3 illustrates the case of a 26 year-old female patient who had undergone 3 previous trans-sphenoidal surgeries for Cushing's disease. There was a 6 × 3 mm residual lesion in the right side of the

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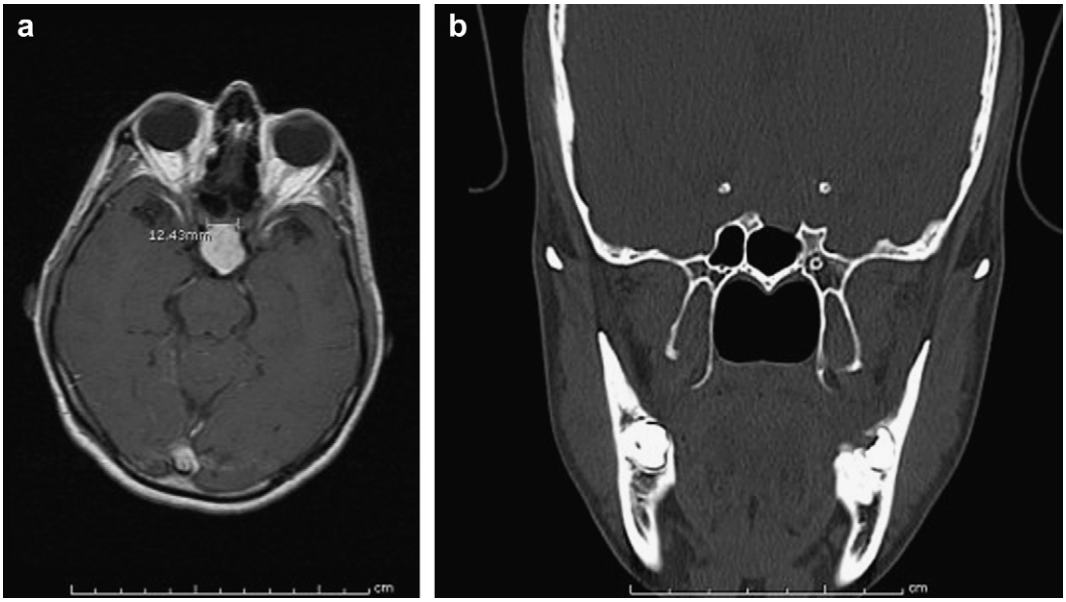

Fig. 1. (a) Axial contrast image showing a residual pituitary adenoma with a cavernous intercarotid distance of 1.7 cm; (b) CT bone window showing the previous entry site close to the petrous and cavernous ICA.

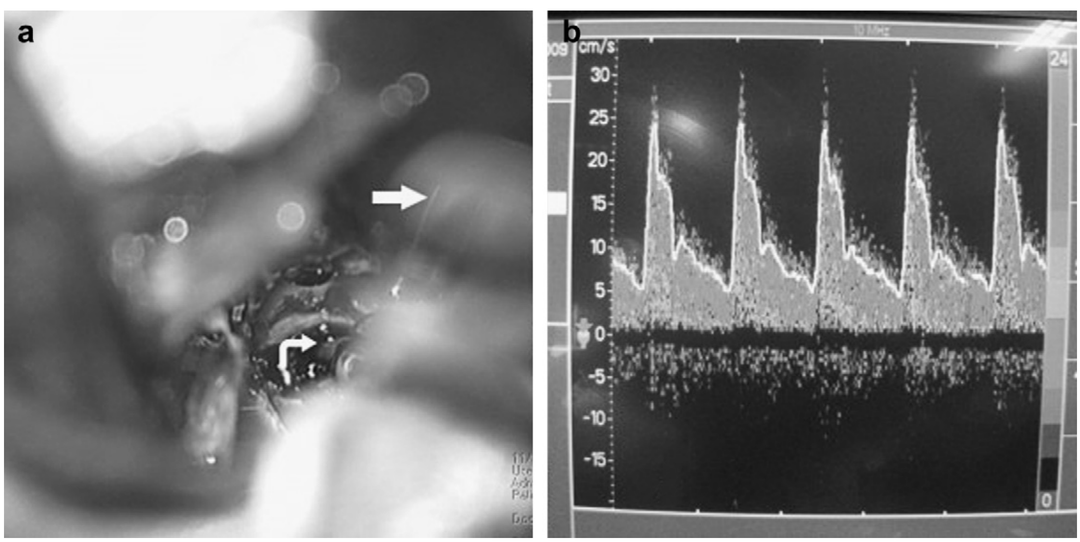

Fig. 2. (a) 3 MHz Doppler probe (curved arrow) placed on dural surface, held between the cusps of a biopsy forceps (straight arrow); (b) Initial Doppler trace of the ICA at a depth of 3 mm.

sella in close relation to the cavernous ICA. We used Stealthstation® neuronavigation system (Medtronic Inc, Minneapolis, MN) for mapping a trajectory into the sphenoid sinus and sella, using 7 fiducials with an accuracy of 1.2 mm. These fiducials, centred on the glabella, were placed on the forehead and maxillary eminence on either side. The stealth wand not only helped us in selecting the portal of entry, but was also helpful in avoiding injury to the cavernous ICA during incision on the sphenoidal scar tissue and decompression of the micro-adenoma (Fig. 4).

2.3. Material and methods

2.3.1. Colour Doppler sonogram

The entry to the sphenoid sinus is guided by regular fluoroscopy using a C-arm (Siremobil Compact, Seimens, Germany). At the lateral angle of the previous bony exposure, the sterilizable Doppler transducer is held at 90° to the soft tissue or dura. The depth of insonation is gradually increased by 0.2 mm till a depth of 7 mm is reached. In case no blood flow in the ICA is observed at a given site, the probe is moved superio-inferiorly in the lateral position and then medially till the ICA flow waves are picked up. Throughout the procedure, the autogain function of the Doppler sonogram is kept switched off.

The position of the artery can be mapped by moving the probe in a superior or inferior direction once ICA flow is observed at a given site (Dusick et al., 2007). In our cases, the average depth of insonation was 4 mm (range 2–7 mm) and the average flow velocity was 55 cm/s. Once the site and direction of ICA is marked, the dura is opened with a number 11 blade on a curved handle. By using a microprobe 1 mm in diameter, vessels located within 7 mm from the probe can be easily detected (Asthagiri et al., 2006). Though the usage of a biopsy forceps to hold the probe limits manoeuvrability