CLINICAL TECHNIQUES AND TECHNOLOGY

Endoscopic transnasal resection of anterior skull base malignancy with a novel 3D endoscope and neuronavigation

Resezione transnasale endoscopica di neoplasia della base cranica anteriore con tecnica endoscopica 3D e neuronavigazione

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SUMMARY

The surgical treatment of sinonasal malignancies is in continuous evolution. In selected patients, endoscopic resection has become a sound alternative to traditional external approaches. Further improvements are necessary to enhance the possibilities of endoscopic transnasal resection of sinonasal malignancies. We present a case of intestinal-type adenocarcinoma of the left nasal fossa eroding the skull base that affected a 56-year-old male. The patient was surgically-treated by means of a four-hand binarial endoscopic transnasal resection using a 3D endoscopic system and neuronavigation. Surgery was completed in 5 hours without significant complications. Surgeons were able to recognize and manage anatomical structures, and to control bleeding easily thanks to the bimanual technique and 3D visualization. The new 3D scopes and the bimanual technique under the guidance of a navigation system represent an interesting solution that can overcome the traditional limits of the traditional set up currently used.

KEY WORDS: Endoscopy • Skull base • Three-dimensional • Sinonasal cancer

RIASSUNTO

Il trattamento chirurgico delle neoplasie naso-sinusali è in continua evoluzione. La resezione endoscopica rappresenta una valida alternativa agli approcci esterni in determinati pazienti. Un ulteriore miglioramento della tecnica è necessario per massimizzare le possibilità di una resezione endoscopica transnasale delle neoplasie nasosinusali. Nel presente articolo riportiamo il caso di un uomo di 56 anni affetto da adenocarcinoma di tipo intestinale della fossa nasale sinistra con interessamento della base cranica. Il paziente è stato trattato chirurgicamente attraverso un approccio transnasale endoscopico utilizzando un sistema endoscopico 3D e con l'ausilio del neuronavigatore. L'intervento è stato completato in 5 ore senza complicanze. È stato possibile riconoscere e gestire le strutture anatomiche e controllare il sanguinamento con facilità grazie alla tecnica bimanuale e alla visualizzazione tridimensionale. I nuovi endoscopi tridimensionali, insieme ad una tecnica bimanuale e all'aiuto dei sistemi di navigazione, rappresentano una soluzione interessante che può superare i limiti dell'armamentario endoscopico tradizionale.

PAROLE CHIAVE: *Endoscopica • Base cranica • Tridimensionale • Tumori nasosinusali*

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Introduction

Sinonasal malignancies have been historically treated by external approaches. Recently, endoscopic endonasal surgery has become a valuable opportunity in cases of selected malignancies of the paranasal sinuses and anterior skull base [1]. From a technical viewpoint, this type of procedure may need intracranial dissection, and for this reason should be performed by experienced surgeons. Typically, the surgeon with an otorhinolaryngologic background holds the endoscope in one hand and uses the other hand to work, while the assistant provides a second and third hand [2]. In this way, the neurosurgical dissection technique is lost, and the "feeling" with the operative field is reduced. This is in contrast to external and microscopic approaches, in which surgical work is performed bimanually. Furthermore, in traditional endoscopic techniques, the surgeon works in a 2D environment. In other words, with the current endoscopes there is a lack of perception of depth. On the other hand, it is also true that experienced surgeons can gain 3-dimensionality by using visual and haptic cues, dynamic movements of the scope, light and shadows and sound anatomical knowledge. Given the fact that we are convinced that surgery is a matter of vision, it is quite obvious that depth perception can help the surgeon in performing complex tasks. In this respect, it has been re-

ported that 3D neuroendoscopy during pituitary surgery offers subjectively improved depth perception for both neurosurgeons and otorhinolaryngologists [3]. Moreover, especially in cases in which anatomy is distorted by the pathology or in children in which anatomy is more complex, the help of the neuronavigation is clearly fundamental. We are strongly convinced that the ideal surgical procedure would offer both the surgeon and patient the distinct advantages of 3D vision, bimanual dissection and neuronavigation guidance [4].

In this report, we present our first experience with a patient presenting sinonasal intestinal type adenocarcinoma of the left nasal fossa (T4a) that was managed by a four-hand binarial resection, using a 3D scope (Visionsense Ltd, Petach Tilka, Israel) under the guidance of neuronavigation (Medtronic®).

A critical discussion of the pertinent literature is given, focusing on technical and technological advantages and limits, pointing out current drawbacks and possible areas of further refinement and improvement.

Technique and case report

A 56-year-old male patient with a sinonasal intestinal type adenocarcinoma of the left nasal fossa eroding the anterior cranial fossa floor (T4a) underwent surgical intervention according to a standardized resection technique [2] with sound oncological principles [1]. The procedure was conducted principally under 3D visualization (Visionsense Ltd, Petach Tilka, Israel), and HD 2D scopes (Karl Storz, Tuttlingen, Germany) were used as leading optic system only in the early phases of the procedure, and compared to the 3D system in different steps. Magnetic neuronavigation (Medtronic®) was used during the entire procedure to confirm the orientation of the surgeon. The surgeons wore stereoscopic glasses during the procedure (Fig. 1). No discomfort was reported by surgeons or other personnel either during the procedure or afterwards. The operation lasted about 5 hours. Subjectively, the surgeons felt at ease with the 3D environment, especially in intracranial dissection. The ability to recognize structures is indeed important, especially when the operative field is wide. In a narrow field, the 3D system created some additional difficulties in performing traditional maneuvers. Skull base plasty was performed according to our standard technique [1] with no difficulties. Most of the procedure, with the exception of only the first phases necessary to gain adequate space for working, were conducted with bimanual binarial dissection. A third and a fourth hand were added when necessary by the other surgeons. The ability to manage anatomical structures and to control bleeding were significantly improved with bimanual dissection.

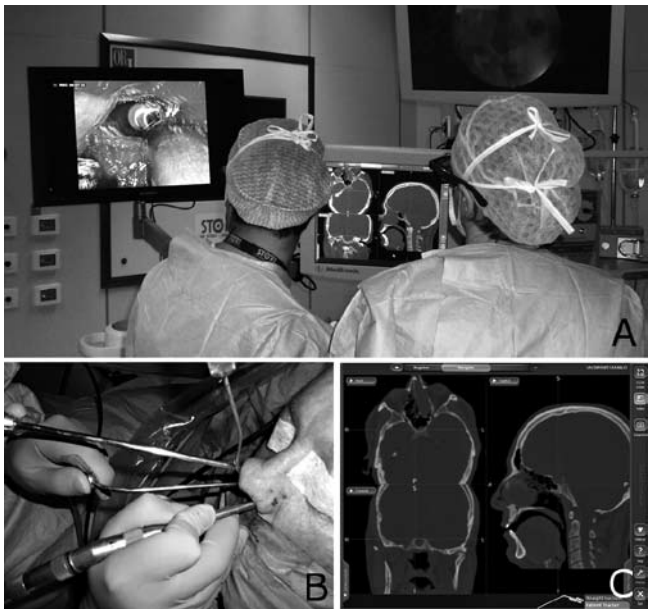

Fig. 1. The operating room set-up was similar to standard endoscopic skull base surgery. Surgeons operated with the aid of stereoscopic glasses (a). Surgery consisted in an endoscopic transnasal binarial approach (b) with intraoperative image guidance (c).

Discussion

The management of skull-base lesions is challenging. In recent years, endoscopic techniques have gained popularity and have proven to be effective and oncologically safe in selected sinonasal and anterior cranial fossa malignancies [1]. We agree with Kupferman et al. when they state that the ideal surgical technique would offer the distinct advantages of 3D vision, bimanual surgical dissection under the guidance of a navigation system [4]. This is simply related to the fact that human anatomy is obviously in 3D, and for this reason perception of depth is of significant help in performing any type of surgical procedure.

In this respect, typical microscopic neurosurgical approaches offer some of these opportunities at the price of limited conic vision. In contrast, and for this reason, an endoscopic endonasal approach has gained popularity, given the wide and dynamic vision offered during the procedure. The possibility to examine around a corner is another well known advantage of the endoscopic technique. Among the typical drawbacks of an endoscopic approach, we underline the 2-dimensional working environment and reduced maneuverability, especially when working in narrow corridors. As underlined, traditional endoscopes provide HD 2D images, and in these circumstances depth perception is based on the surgeon's knowledge of spatial anatomy, visual and tactile feedback during the surgical procedure and the dynamic movement of the scope. Notwithstanding, these cues can be misleading [5] and real-time depth perception becomes of vital importance, especially in cases of distorted anatomy [6]. In this respect, visual perceptual illusion has been demonstrated as the primary cause of error in laparoscopic surgery [7]. Furthermore, to strengthen this concept, we underline that, especially when dealing with complex areas where critical structures are separated by small spaces, the lack of depth perception can lead

to dangerous mistakes. On the other hand, many skilled surgeons have demonstrated the ability to overcome these limits through extended experience. In this respect, our 15-year experience with more than 200 cases of sinonasal and anterior cranial fossa malignancies has demonstrated that the 2D technique should also be considered safe in skilled hands [1]. Nevertheless, it is quite obvious that depth perception is crucial to reduce the risk of injury to anatomic structures, and a significantly higher level of efficiency has been demonstrated using the 3D system compared to 2D endoscopes [5]. Different conclusions have however been reached by other authors [8]. At the moment, debate is still open; notwithstanding this, although without any definitive value, our preliminary impressions on 10 cases convinced us that 3D technology can be helpful in many circumstances. From a clinical viewpoint, thanks to the pioneering work of the New York group, the 3D endoscopic technique has become an opportunity for all surgeons involved in sinonasal and skull base surgery [3 5 6 9 10]. We maintain, as others [3], that improved visualization has the potential to correct the limitations of the traditional 2-D endoscopic technique and thus may have a significant impact on overall outcome. Our case, involving about 5 hours of surgery, was conducted under 3D vision with no difficulty, and caused no discomfort for surgeons or other personnel. Furthermore, like others [3], we did not find any 3D images that were confusing or lacking in resolution.

Regarding the technique, it is becoming more evident that the use of a bimanual binarial dissection technique, popularized by the Pittsburgh group, represents a key concept in managing skull base lesions; this is especially due to better control of bleeding and improved manipulation of structures. Our case confirmed that the combination of a 3D environment with a bimanual binarial dissection renders the surgeon much more confident with the procedure.

Among the current drawbacks with the current 3D system, we underline that surgery in narrow spaces, due to the contracted viewing angle of the 3D system, is more complex and a little disorientating compared to traditional 2D endoscopy. Furthermore, at the moment, 3D technology offers inferior sharpness and contrast compared with the new HD 2D systems. We did not find the lack of resolution particularly disturbing.

Among the potential areas of improvement, we underline that more angled scopes would be useful in some steps of anterior cranial fossa surgery, especially in frontal areas. The eyeglasses will soon be replaced by autostereoscopic monitors that display the images in 3-D space. Furthermore, new probes for nerve labeling would be useful in detecting, with or without special screens, nerves in critical areas and in revision cases.

Conclusions

We maintain that new 3D scopes and the bimanual technique under the guidance of a navigation system represent an interesting solution that can overcome traditional limits of the current traditional set up. This is particularly true in complex cases such as anterior cranial base malignancies. Further experience is mandatory.

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