Modern Surgical Technologies Used in Different Ethmoid Tumors Approaches

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The aim of this paper is to underline the importance of modern technologies and experience of surgeon in using them in ethmoid tumors approaches. The method consists of a general and synthesized presentation of modern technologies and identifying patterns of their utilization according to our experience. differentiated utilization of all technologies combined with all types of techniques according to preoperative plan (tumor extension evaluated by imaging, endoscopic aspect, Hystopatological and Immunochemistry exams), knowledge and experience of surgeon. Combined surgical technique is the best choice for the approach of malignant ethmoid tumor and some benign tumor extended to the risk regions (skull base and orbit) with tendency to invasion as inverted papilloma. It is very important for the surgeon to be able to adapt and change his technique at any intraoperative moment and to have skills in using all modern surgical technologies. For all most benignant ethmoid tumors surgeon must apply all knowledge and skills in endoscopic surgery using all modern technologies.

Keywords: modern technologies, combined approach, video assisted control

Acquiring knowledge and learning all the techniques and technologies used in surgical approach of ethmoid tumors are essential in preparing ENT surgeon so that he should cover both entire tumor pathology, including those with extension to risk regions (orbit and skull base) having curative ablation target, as well complications that can occur intraoperative and postoperatively. Modern technologies are in a constant developing so their mastery and adaptation during surgery represent a real challenge for the surgeon.

Surgical techniques in ethmoid tumor approach

- Endoscopic surgery – for benign ethmoid tumors;
- combined technique (external approach and video assisted control) - malignant ethmoid tumor and some benign tumor extended to the risk regions (skull base and orbit) with tendency to invasion as inverted papilloma;
- classical techniques (only external approach) –for malignant ethmoid tumor – different types of approach modified and adapted according location and extension of tumor (importance of CT or MRI in preoperative plan);
- reconstructive techniques – using flaps after removing exteriorized tumors, different techniques for closing CSF leak.

Surgical technologies in different approaches of ethmoid tumor pathology

Video assisted control – importance

- Evaluation of tumor extension to skull base (identifying osteolysis+/- infiltration of dura) and orbit (orbital periosteum, content of the orbit)
- Ensure a tumor excision more complete (from sphenoid sinus, posterior ethmoid sinus, skull base and orbit) especially " tumor nests " adherent to the risk regions (skull base and orbit)
- Identifying dehiscence of carotid canal, dura mater denudation areas (sometimes CSF leaks), optic nerve (when tumor is extended until posterior pole of the orbit)
- Applying reconstructive techniques at skull base, especially for closing CSF leaks

We are using rigid endoscopes 0, 30,45,70° (different lengths and diameters: 4mm, 2.7mm, 1.9mm), flexible video endoscope with "chip on the tip" modern technology [1] (fig. 1) and HD imaging and NBI technology (fig.2). Delimitation of tumor margins using NBI technology is supported by hystopathological and immunochemistry exams of the tumor margins samples.

Fig. 1. Video endoscope with "chip on the tip" modern technology

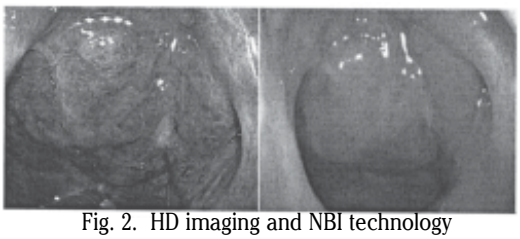

Fig. 2. HD imaging and NBI technology

Surgical drill - importance

- Drilling the bone when the tumor is extended to the bone structures, which are partially destroyed of it (malignant tumor, inverted papilloma);
- creates " bony columns" especially at the orbit level (when the tumor is extended to the orbit), preserving the static of the ocular globe and participating to the reconstruction of bone and skin planes ;
- excision of ethmoid or frono-ethmoidal osteomas and osteogenic tumors ;
-Widening front-nasal duct after removing tumor lesions or fronto-ethmoidal associated inflammatory lesions.

We are using cutting or diamond drills different forms (spherical, cylindrical, conical) or dimensions adapted to

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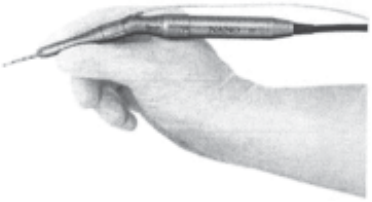

Fig. 3. Modern surgical drills

the bone structure (thickness, hardness), work space and tumor localization (risk zones: skull base and orbit). Modern surgical drills have micro motors with weight up to 300g. [1] (fig. 3)

Surgical Shaver system (microdebrider) – characteristics

- surgical instrument used especially in endoscopic surgery – for rhino-sinus inflammatory diseases;
- tumor tissue ablation (especially for benign tumors but also for malignant);
- disadvantage in tumor pathology is loss of the material for complete biopsy useful for complete Hystopatological result (as it happens in nasal polyposis and inverted papilloma with malignant transformation islands).

It is an instrument that revolutionized endonasal endoscopic surgery. It is made of one micro motor that oscillate and concentric blades that cut and aspire mucosal and bone pathological material [1]. There are many shaver blades with different diameters, angulations and work lengths (including drill blades) which made possible many techniques in endoscopic surgery approach (fig. 4)

Fig. 4. Shaver blades with different angulations and work lengths

Radiosurgery– benefits

- Hemostasis control
- Ablative technology, whose cutting effect didn't work as a thermic destruction of the tissue (it is used in endoscopic surgery as well as in combined approach with video assisted control). Way of action of radiofrequency at the tissue level is done by contact between tissue and radiofrequency electrode. Through the electrode passes an electric wave with 4 MHz frequency that sends this vibration to the water from cells too leading to cell explosion.

-Important benefits in surgery of extended ethmoid tumor to the orbit or skull base, because the 4 MZ current wave used for cutting produces a reduced thermic effect in proximity of application so it is one of technologies used at the skull base level [1]

- "Scanning "of remnant tumor bed, after tumor ablation, for hemostasis and destruction of eventual remnant tumor cells.

The tips of the instruments used for radiofrequency unit have different shape, angulations and dimensions. (fig.5)

Coblation - importance

- Tumor ablation
- Tumor volume reduction
- Hemostasis control

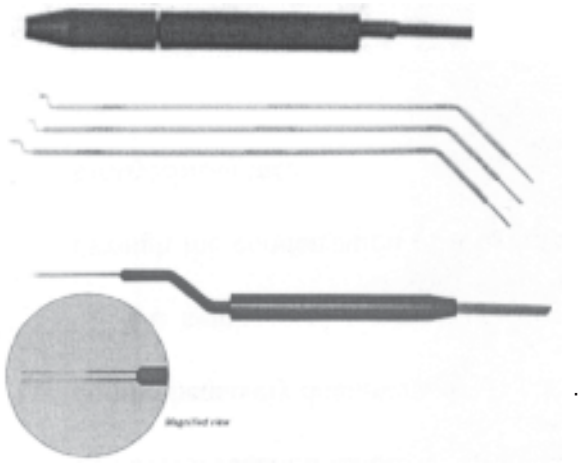

Fig 5. Instruments used for radiofrequency

- Used in endoscopic surgery and also in combined approach

Derived from "controlled ablation", the name refers to the non-heat driven process of surgically dissociating soft tissue by using bipolar radiofrequency energy to excite the electrolytes in a conductive medium, such as saline solution, to create a precisely focused plasma field. Energized particles, or ions, in the plasma field have sufficient energy to break, or dissociate, organic molecular bonds within soft tissue at relatively low temperatures [3]. This enables Coblation devices to volumetrically remove target tissue with minimal damage to surrounding tissue. [3] Coblation devices can also provide hemostasis and tissue shrinkage capabilities. The coblation generator used in our cases for tumor ablative time involving skull base is Arthocare Coblator II and coblation probe is the one used for the first time for nasal polyposis ablation [2] (fig.6).

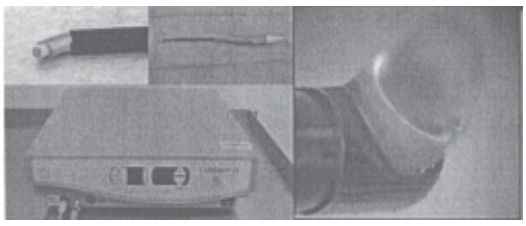

Fig. 6. Coblation devices

Argon plasma – benefits

- vascular tumor excision;
- hemostasis;
- destruction of eventual remnant tumor cells and hemostasis "scanning" the remnant tumor bed;
- can be used in combined approach under video assisted control

This is a non-contact technology and parameters changeable according to target tissue as: cautery power, argon flow, distance from the probe tip to the tissue. [1] (fig. 7)

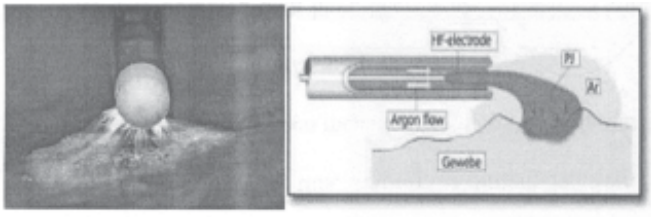

Fig. 7. Argon plasma devices

The Sonopet Ultrasonic Aspirator – benefits

It is used in soft tissue dissection as well as in bone dissection nearby delicate structures (large vessels, meninges, orbit contents) without damaging them [1].

The precise fragmentation of target tissue is simultaneously accompanied by suction of tissue fragments and irrigation so that thermal effects on the neighboring tissue are negligible.

There are different cutting tips depending on what kind of tissue type will be approached: tips for soft tissue, tips for fibrous tissue, tips for bone [1].

It may be used in ethmoid tumors ablation (including those with osteogenic structure) extended to the orbit or skull base with the big advantage that does not destroy nerves and vessels [1].

NBI (Narrow Band Imaging) – operating principle

This is a new technology which changes, in real time light, spectrum whereby is visualized the flexible or rigid endoscopic image by applying a color filter in front of the Xenon light bulb.

The obtained light contains just two wave frequencies, respectively 450nm and 540nm. These light frequencies are strongly absorbed by hemoglobin.

When respiratory mucosa is exposed to the white light the short light frequencies penetrates the superficial mucosa and higher light frequencies penetrates deeply [1].

The NBI light, having low frequency, penetrates only the superficial layer and it is strongly absorbed by hemoglobin. In this way grows the contrast between blood vessels and mucosa.

Capillaries from superficial mucosa layer are visualized in brown and the veins from submucosa are colored in cyan (fig. 8).

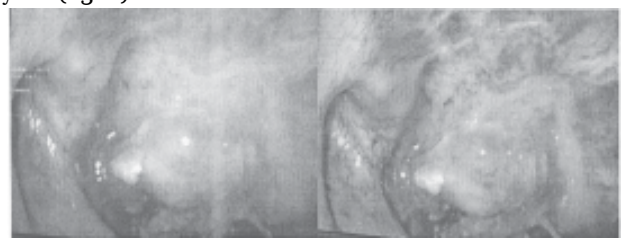

Fig. 8. NBI image – tumor delimitation

It is a modern diagnosis method in ethmoidal tumor pathology.

It may be used in endoscopic approach and in combined approach of ethmoid tumors with the purpose to delimit as accurately as possible the tumor and its extension at the risk regions (orbit and skull base) for achieving a complete resection with safety oncological edges (fig.8).

After tumor resecting – NBI is useful in identifying the tumor outstanding (small " nests") at the risky zones: orbit and skull base in order to apply radiofrequency or modern technology with Argon Plasma.

Similar technologies to NBI: autoflorescenta, I-Scan, F.I.C.E. (FUJI Intelligent Chromo Endoscopy) are not used in our country.

Cleaning systems for the endoscope lens

The system works by introducing saline between metal sheath and endoscope, by a pump [3]. The system irrigate and aspirate saline from the distal lens of endoscope providing a correct visualization of the entire surgical field. The sheaths have 18 and 24 cm length and they are designed for rigid endoscope of 0, 30, 45, 70°.

These type of cleaning system is very useful in ethmoid tumor surgery extended to orbit and skull base because allows an immediate cleaning of the endoscope distal lens without removal the instrument from the nasal cavity [3] (fig.9)

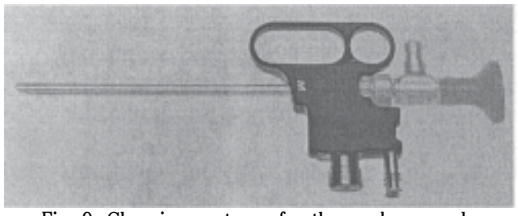

Fig. 9. Cleaning systems for the endoscope lens

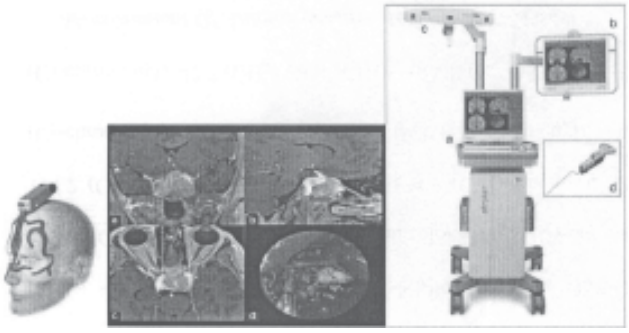

Fig. 10. Neuronavigation system

Neuronavigation

A modern technology, a set of computer-assisted technologies, for surgical guide that directs surgeon showing to him in real time the position of the tip of surgical instruments in relation to different anatomical endonasal and sinus structures and to the level of the orbit and skull base.

It has the following components [4]:

1.Board navigation that records the triangulate position of the surgical tracker and transmits it in real time to the informatics system.

2. The surgical tracker , that can be by itself or attached to the surgical instruments measuring the position of the surgical instrument.

3. The reference tracker that will determine the used surgical instrument length and the position of the tip.

- The informatics system in which are imported CT, MRI or MRI - angiography images, that analyses in real time the surgical instrument position and positions the tip of the instrument in real time in the 3 types of sections axial, coronal and sagittal. It has the possibility to mixt CT, MRI or MRI - angiography images for offering better information about the pathology that involve skull base and/or orbit.

The monitor of the navigation system is divided in 4 quadrants. Three of them displays information about anatomy imaging and tip of surgical instrument positioned in real time to anatomy imaging of the patient and the fourth quadrant that displays endoscopic images [5] (fig. 10).

Used instructions for the neuronavigation system

Pathology that involved skull base, orbit, optical nerve or internal carotid arterys.

CSF Fistula or bone defects at the skull base level.

Benign or malign tumors with sinus origin but involving skull base and/or orbit.

Revision of rhino sinus surgery.

Sinus anatomy post operator destroyed or after trauma

Extensive nasal polyposis.

Pathology that involves frontal sinus, posterior ethmoid and sphenoid sinus [6].

Navigated Control

It was designed like a program in the software of navigation system offering possibility of registration of a surgical work volume so that , when the tip of the instrument get out of work volume, the shaver or surgical drill are automatically off by the neuronavigation system.

The term of "Navigated Control" for the surgical instruments mechanical operated (shaver and surgical drill) was promoted by Lüth in 2002, who effectuated a clinical - surgical study on 30 subjects [3]. Because both shaver and surgical drill remove big tissue volumes in a short time they are considered dangerous especially in hands of beginners surgeons [4] for the F.E.S.S. [3] but also for the experimented ones in extended tumor surgery.

The important advantage of this system is to limit iatrogenic lesions in extensive surgery for rhino-sinus tumor pathology.

Auxiliary surgical technologies

Augmented Reality - preoperative determination by the surgeon of anatomical landmarks or surgical risk elements most often hidden behind other anatomical elements, that will be displayed in real time on endoscopic imagine of the neuronavigation system.

Virtual Reality – Simulation - by processing patient imaging, the computer can simulate volumetrically the anatomy of the patient and the surgeon can simulate the whole operation using the two technologies.

XII Robotic surgery Robotic system Da Vinci consists of three components: surgeon console, patient console and Viewing System

Surgeon console Is the control unit of the surgical robot. The surgeon has available two joystick and monitor with 3D projection.

Patient console has four articulate arms, one of them is for manipulation of endoscopic camera. The diameter of the multiple articulate arms is 10 and 5 mm [5].

Viewing System is equipped with 3D endoscopes high definition, flexible that offer a high quality image. The images are transmitted both to surgical console and HD monitor to be visualized or transmitted and used for telemedicine and teleconferences [5]. We do not have experience with this kind of surgery.

Conclusions

Combined surgical technique is the best choice for the approach of malignant ethmoid tumor and some benign tumor extended to the risk regions (skull base and orbit) with tendency to invasion as inverted papilloma.

It is very important that the surgeon to be able to adapt and change his technique at any moment intraoperative and to have skills in using all modern surgical technologies.

For all most benignant ethmoid tumors surgeon must apply all knowledge and skills in endoscopic surgery using all modern technologies.

From our clinical experience we obtained better results when we had available and we have used modern technologies both in endoscopic approach and in combined approach (open techniques with video assisted control) We do not use anymore classic external approach.

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