Three dimensional endoscopy

A paper describes a simple method for obtaining endoscopic three-dimensional anatomic images for teaching purposes.

This method uses a single endoscope that provides regular, two-dimensional images. Obtaining the three-dimensional image requires the superposition of two similar but slightly different images of the same object. The set of images, one mimicking the view of the left eye and the other mimicking the view of the right eye, constitute the stereoscopic pair of images obtained with the endoscope. For constructing three-dimensional images, the distance between the pictures must approximate the interpupillary distance.

The technique involves fixing the endoscope in position using a self-retracting arm and placing the specimen on a simple sliding tray with an adapted millimeter scale to control the distance between the pictures. The initial still image is captured and the tray on which the specimen sits is shifted up to 3 - 4 mm laterally to capture the second image. As a general rule, one can calculate the distance between the pictures by moving the specimen laterally 1/30 of the distance between the lens and the object. Images captured are processed using anaglyphic technique for printing and horizontal-vertical polarization of light for presentation to larger audiences.

Images produced in this way may aid in the understanding of the depth of different structures and ease of learning curve for the use of the endoscopy in neurosurgery [1)].

Three dimensional endoscopy has been actively pursued for decades by endoscopic surgeons in multiple surgical specialties. However, its clinical role has been limited due to technical limitations as well as successful adaptation by endoscopic surgeons to monocular cues offered by 2D technology.

Until recently, stereoscopic technology included variations of dual channel video, dual chip-on-the-tip, and shutter mechanism, as well as various 3D displays. Over the past decade a novel 3D endoscopic technology was introduced. This technology used a lenticular array of lenses in front of a single video chip at the distal end of an endoscope to generate a stereoscopic view of the surgical field. Also known as the 'insect eye' technology since it mimics the compound eye of arthropods, this endoscope has reinvigorated the field of 3D endoscopic surgery [2)].

Endoscopic transsphenoidal approach with three dimensional endoscope, is a addition to augment the transsphenoidal approach for anterior skull base and parasellar lesions.

A PubMed literature review was performed by Zaidi et al. to identify and analyze all studies pertaining to Three dimensional endoscopic endonasal skull base surgery.

Twenty-six articles were identified: 14 clinical articles, 5 simulated environment studies, 5 human cadaveric studies, and 2 expert opinions. Among clinical studies, a total of 262 patients were treated for the following 257 pathologies listed in the articles: 190 suprasellar/parasellar lesions (73.9%), 41 ventral skull base lesions (16.0%), 19 sinonasal pathologies (7.4%), and 7 CSF leak repairs (2.7%). Complication rates, operative time, length of hospital stay, and extent of tumor resection were equivalent between 2D and 3D endoscopy. However, all studies report that subjective depth perception and spatial orientation were markedly improved with 3D technology. Three studies (11.5%) concluded that there was no clinically significant surgical benefit in switching from 2D to 3D endoscopy. All cadaveric studies and expert opinions concluded that 3D endoscopy improved identification of key anatomical structures and was superior to 2D endoscopy. Simulated environment studies demonstrated that 3D endoscopy improves speed and accuracy of endonasal tasks, more so in novice surgeons.

The findings suggest that this modality provides improved surgical dexterity by affording the surgeon with depth perception when manipulating tissue and maneuvering the endoscope in the endonasal corridor [3].

Case series

2013

Felisati et al. discuss the early experience as ENT surgeons with the use of a purely 3D endoscopic expanded endonasal approach for supradiaphragmatic lesions in 10 consecutive patients. In this article they focus on the surgical technique, the complications, the outcome, and more importantly the advantages and limitations of the new device.

They believe that the new 3D system shows its main drawback when surgery is conducted in the narrow nasal spaces. Nevertheless, the improved knowledge of the three-dimensional nasal anatomy enabled the ENT surgeon to perform a more selective demolition of the nasal structures even in the anterior part of the nose. The depth perception obtained with the 3D system also permitted a better understanding of the plasticity of the surgical defects, increasing the confidence to perform successful skull base plasties.

They believe that, for both the ENT surgeon and the neurosurgeon, the expanded endonasal approach is the main indication for this exciting tool, although larger prospective studies are needed to determine the equality to the 2D HD endoscope in oncological terms [4].

Over an 18-month period, 160 operations were performed using solely endoscopic techniques. Sixty-five of these were with the Visionsense VSII 3-D endoscope and 95 utilized 2-dimensional (2-D) high-definition (HD) Storz endoscopes. Intraoperative and postoperative findings were analyzed in a retrospective fashion.

Comparing both groups, there was no significant difference in total or surgical operating room times comparing the 2-D HD and 3-D endoscopes (239 minutes vs 229 minutes, P = .47). Within disease-specific comparison, pituitary neuroendocrine tumor resection was significantly shorter utilizing the 3-D endoscope (surgical time 174 minutes vs 147 minutes, P = .03). These findings were independent of resident or fellow experience. There was no significant difference in the rate of complication, reoperation, tumor resection, or intraoperative cerebrospinal fluid leaks. Subjectively, the 3-D endoscope offered increased agility with 3-D techniques such as exposing the sphenoid rostrum, drilling sphenoidal septations, and identifying bony landmarks and suprasellar structures.

The 3-D endoscope is a useful alternative to the 2-D HD endoscope for transnasal anterior skull-base surgery. Preliminary results suggest it is more efficient surgically and has a shorter learning curve. As 3-D technology and resolution improve, it should serve to be an invaluable tool for neuroendoscopy [5].

2009

Thirteen patients underwent endoscopic endonasal approach. A 6.5-, 4.9-, or 4.0-mm, 0- and 30-degree rigid three dimensional endoscope.

Patients were followed prospectively and compared with a matched group of patients who underwent endoscopic surgery with a 2-dimensional (2-D) endoscope. Surgeon comfort and/or complaints regarding the endoscope were recorded.

The 3-D endoscope was used as the sole method of visualization to remove 10 pituitary neuroendocrine tumors, 1 cystic xanthogranuloma, 1 metastasis, and 1 cavernous sinus hemangioma. Improved depth perception without eye strain or headache was noted by the surgeons. There were no intraoperative complications. All patients without cavernous sinus extension (7of 9 patients) had gross tumor removal. There were no significant differences in operative time, length of stay, or extent of resection compared with cases in which a 2-D endoscope was used. Subjective depth perception was improved compared with standard 2-D scopes.

In this first reported series of purely 3-D endoscopic transsphenoidal pituitary surgery, they demonstrate subjectively improved depth perception and excellent outcomes with no increase in operative time. Three-dimensional endoscopes may become the standard tool for minimal access neurosurgery [6].

1999

Four cases are described in which stereoendoscopy was used as either a primary means of visualization or as an adjunct to the operating microscope in conventional open neurosurgical procedures. The authors believe that stereoendoscopic vision is a significant advance in endoscope technology and will play a large role in the popularization of minimally invasive techniques in neurosurgery [7].

Case reports

Endoscopic Transsphenoidal Pituitary Surgery: Recurrent pituitary neuroendocrine tumor: 3-Dimensional Operative Video [8] [9]

Endoscopic transsphenoidal pituitary surgery: transsphenoidal approach to the sella and sellar closure with septal flap: 3-dimensional operative video [10].

Endoscopic transsphenoidal pituitary surgery: tuberculum sellae meningioma: 3-dimensional operative video [11]

Endoscopic transsphenoidal pituitary surgery: 4 unique cases of craniopharyngioma: 3-dimensional operative video [12].

3-dimensional endoscopic transsphenoidal pituitary surgery: Rathke's cleft cyst: operative 3-dimensional video. [13].

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