

Section: Mechatronik

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Abstract-Title:

DIE MASTOIDEKTOMIE MIT NAVIGATED CONTROL – ERSTE TECHNISCHE
STUDIETHE MASTOIDECTOMY WITH NAVIGATED CONTROL - FIRST TECHNICAL
TRIAL

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Abstract-Text:

Purpose

Patients who are treated with a mastoidectomy suffer from an inflammation of the petrosal bone. The intervention is a time consuming landmark based surgery and usually is performed with a powered drill. A co-morbidity of 2-6% for the risk structures can be found in the literature. Surgeons use high resolution CTs to study patient anatomy/pathology to plan the intervention. Today this data can be easily used for navigation. Navigated Control (NC) describes the control for a power driven instrument which is controlled by a surgeon. In addition, the power supply is controlled according to the position of the instrument relatively to a preoperatively segmented workspace. When the drill tip exceeds the workspace the power is shut off. The aim of this study is to show the feasibility of NC for a mastoidectomy.

Method

The ICCAS Electronic Phantom (ElePhant) was used for evaluation. It is a head phantom generated by a rapid prototyping method based on original patient data. Different petrosal bone models can be reproducibly connected to the phantom. The bone models contain three risk structures: The facial nerve, the horizontal semicircular canal and the sigmoid sinus. Their damage can be opto-electronically quali- and quantified. The phantom is bearing a dental splint for registration. Workspace segmentation (within the phantom navigation data) was done corresponding to a mastoidectomy. An optical navigation system is connected to a control unit which controls the drive of the drill. Phantom and drill are navigated. The drilling was performed on 15 different petrosal bone models performed by 5 inexperienced test persons and 5 experienced ear surgeons. The test persons were asked to perform a mastoidectomy according to the planned workspace. The resections were divided into three different groups: Group 1: Inexperienced test persons 5 mastoidectomies with NC. Group 2: Experienced Ear-Surgeons 5 mastoidectomies without NC.

Group 3: Experienced Ear-Surgeons 5 mastoidectomies with NC.

Investigated were the following parameters: Resected volume, time, number and grade of

damage. After the procedure the petrosal bone models were CT scanned and subsequently analyzed with measuring software (Polyworks®, Mimics®).

Results

After the CT scan of the petrosal bone models the sigmoid sinus, the horizontal semicircular canal and the facial nerve could be detected as risk structures. Thus a workspace respecting the structures and corresponding to a mastoidectomy could be segmented. This process required 17minutes. The drill and phantom could be registered and tracked. The resection time was:

Group 1: Ø 2009.8 s

Group 2: Ø 715.0 s

Group 3: Ø 817.6 s

The resected volume was correlated to the required time. Thus different drilling speeds were derived:

Group 1: Ø 6.61mm³/s

Group 2: Ø 9.6mm³/s

Group 3: Ø 10.1mm³/s

There was no risk structure damage with NC. Without NC one mechanical damage of 20% of the facial nerve was registered.

Conclusion

The segmentation and implementation of a mastoidectomy with NC is possible. Employing NC elevated the drilling speed with fewer complications. The phantom is close to clinical practice. The investigation was performed with a modified system initially designed for a navigated controlled shaver in paranasal sinus surgery. On ongoing second technical trial with specified hardware overcomes technical deficits. The authors believe that lateral skull base surgery with NC has a great potential for safe risk structure protection, a morbidity reduction, a reduction in intervention time and also in a relief of strain for the surgeon.