

Anatomical Landmarks in Relation to Mastoid Exploration; Distance to Tegmen, Sigmoid Sinus and Semicircular Canal from the Bony Ear Canal

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Abstract

Introduction: Mastoid exploration is carried out in almost all ENT units in Sri Lanka. A Computed Tomography (CT scan) will give detailed anatomical information which assist surgical planning. Unfortunately, in most occasions it is not available due to resource limitations. A low-lying dura, high sigmoid sinus, Korner's septum, lateral semicircular canal are encountered when performing this surgery.

Objective: Establish a data bank of the distance from the inner surface of superior bony canal wall to tegmen, the distance from the outer margin of the posterior bony ear canal to the lateral semicircular canal and the distance to the sigmoid sinus from the posterior bony canal.

Method: A retrospective cohort study was carried out at the ENT unit of the National Hospital, Kandy. All the patients fulfilling the inclusion criteria were selected till the total number reach 50 patients from April 2020 to December 2020.

Results: Fifty mastoid explorations were studied focusing on the anatomical distances from the bony ear canal. The minimum distance from the inner surface of the superior bony canal wall to the middle fossa dural plate (tegmen) was found to be 4 mm. The minimum distance of the sigmoid sinus wall; which was an anteriorly placed sigmoid sinus, from the inner surface of the posterior canal wall was 4 mm. The average distance to the lateral semicircular canal from the outer surface of the bony ear canal was 15.0 mm (16.2-14.2 mm).

Conclusion: The closest distance to the middle fossa dura and the sigmoid sinus was 4.0 mm and the aditus and the lateral semicircular canal encountered more than 14 mm deep from the outer mastoid wall. Therefore choosing a 4.0 mm drill is safe when performing surgery near the middle fossa dura and the unexpected anteriorly placed sigmoid sinus. However, since this study has examined fifty samples; more data and a bigger sample would give a better representation of the population.

Keywords: Mastoid Exploration; Tegmen; Lateral Semicircular Canal; Sigmoid Sinus

Introduction

Background

Mastoid exploration is carried out in almost all ENT units in Sri Lanka. In these situations, a Computed Tomography (CT scan) will give detailed anatomical information which assist surgical planning. Unfortunately, in most occasions it is not available due to resource limitations.

Standard landmarks are followed when performing a cortical mastoidectomy. A low-lying dura, anteriorly placed sigmoid sinus, Korner's septum, lateral semicircular canal, aditus in to the mastoid antrum are encountered when performing this surgery. There are instances, even in experienced surgeons' hands where semicircular canal, (tegmen) dural exposure and sigmoid sinus puncture have occurred. I have seen a very anterior sigmoid sinus during my training.

Standard text books state the anatomical details of the temporal bone and there are few studies done to explore the anatomical landmarks of the temporal bone. Anatomy in relation to mastoid surgery is not studied in most of the books. There are few radiological studies of the temporal bone and very few studies with dry skull bones and cadavers [1-3].

Justification

Cortical mastoidectomy is done with high-speed drills and various sizes of drill bits. If there are prior estimations in the population concerned about the mastoid bone anatomy; the distance from the inner surface of the superior bony canal wall to middle fossa Dura (Tegmen), the distance from the posterior bony ear canal outer rim to the lateral semicircular canal, the distance to the sigmoid sinus from the inner surface of the posterior bony canal; the dissection and the selection of the sizes of the burrs will be facilitated. It will be safer to operate if this data is available without a CT scan, which is a common occurrence in our country. The available data in literature has not provided sufficient information.

Primary objective

To determine;

- The distance from the superior bony canal wall to Tegmen
- The distance to the lateral semicircular canal from the posterior bony ear canal margin

- The distance to the sigmoid sinus from the posterior bony canal, in the local setting.

Literature search

Anatomy of the temporal bone in relation to mastoid surgery is described in very few studies. Most of them are done with radiological evaluations [1,2,4].

The bone specimens are studied very rarely and the numbers are very small. A study with almost 300 bones [3] is a rare study done on Greek adult population.

Studies involving dissection of Temporal bones are lacking in numbers. There is a study done with 20 Temporal bones [5].

Live patients were rarely involved in this type of studies except for a few case studies, but their number is limited.

The objectives of the current study were not addressed in the same manner to estimate safe dimensions in dissecting the temporal bone.

Material and Methods

The study was as a retrospective cohort study at ENT unit National Hospital, Kandy. All the patients fulfilling inclusion criteria were selected from April 2020 to December 2020 until the sample size achieved.

A caliper was used to measure the length in millimeters and the depth was marked on a sterile tooth pick by a needle and a methylene blue mark and measured with the caliper in millimeters. The measurements were done with the help of the operating microscope. The management plan of the patients was not affected due to this study.

Tegmen was identified by the help of the antral seeker, the change of the sound character of the drill and the pink colour of the bone when close to Dura. The sigmoid was identified by the shape and the bluish tinge over the bone. The canal luminal midpoint of the superior canal wall and the midpoint of the posterior canal wall are taken as fixed reference points. All the details were entered to the operative notes to be used for data collection.

The surgical findings were analyzed at the end of data collection. The average distance, maximum and the minimum of the anatomical distances were calculated.

Sample size

Sample size was 50 patients which was feasible estimate in six months duration.

Inclusion criteria

- The patient should have undergone a mastoid exploration in the unit during the period defined above.
- Some of the patients undergo mastoid exploration without CT scans, so the number of CT scans is less than the total operated patients. All patients are taken to measure anatomical landmarks.

Exclusion criteria

- Absence of consent
- Already eroded structures due to the pathology and revision surgery

The data analysis focused on the average anatomical distances.

Study instruments

Consent was taken in a consent form in Sinhala, Tamil and English languages as appropriate for the patient. A data collection form was used to record information which was filled by the principle investigator. Operating microscope and the caliper were used to measure anatomical distance in millimeters.

Data collection

Data collection was done by the principal investigator (Author) with a data collection form.

Ethical clearance

Prior ethical clearance was obtained from the ethical review committee of the National Hospital, Kandy.

Results

Fifty mastoid explorations were studied focusing on the anatomical distances from the bony ear canal. The minimum distance from the inner surface of the superior bony canal wall to the middle fossa dural plate (tegmen) was found to be 4 mm and the maximum distance was 10.0 mm. The minimum distance of the sigmoid sinus wall; which was an anteriorly placed sigmoid sinus, from the inner surface of the posterior canal wall was 4mm and the maximum distance was 14.0 mm. The average distance to the

lateral semicircular canal, from the outer surface of the bony ear canal was 15.0 mm (16.2-14.2 mm).

Tegmen	Sigmoid sinus	Lateral semi. canal	
6.3 mm	10.4 mm	15.0 mm	Average
10.0 mm	14.0 mm	16.0 mm	Max
4.0 mm	4.0 mm	14.0 mm	Min

Table 1

The summary of anatomical data of the mastoid bone during dissection.

Discussion and Conclusion

Mastoid exploration is a common procedure carried out in almost all ENT units in Sri Lanka. In these situations, a Computed Tomography (CT scan) will give detailed anatomical information which assist surgical planning. Unfortunately, in most occasions it is not available due to resource limitation of the particular institutions in Sri Lanka. In most instances, the report of the CT scan given by the consultant radiologist is available without the printed CT films. In the current milieu of Sri Lanka, it is an added advantage if we have the printed CT or the electronic version to be available at the operating theater.

Therefore, there are many occasions where the surgeon has to take clinical decisions during surgical planning as well as during the surgery itself. There may be unexpected findings of low lying dura, anteriorly placed sigmoid sinus or a high jugular bulb encountered during surgery.

During my training in ENT, I have come across such situations, and there were instances of dural exposure as well. These mishaps could be prevented if high resolution CT scan is readily available [4]. Knowledge of mastoid bone anatomy and the availability of the CT scan is useful information for beginners or inexperienced surgeons.

Radiological landmarks of the temporal bone [6].

Training as an ENT surgeon in Sri Lanka under the Postgraduate Institute of Medicine, University of Colombo; is carried out with the supervision of consultant ENT surgeons. One aspect of training is the cadaveric temporal bone dissection under a dissecting

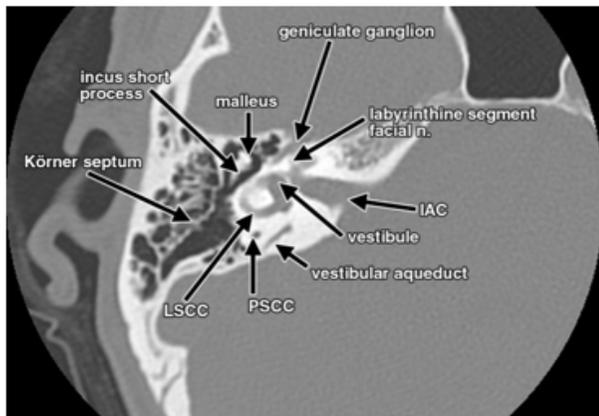


Figure 1

microscope. This improves the trainees' confidence and knowledge immensely, but obtaining specimens and the availability of resources is limited. There were not many studies available for reference [3] and text books also are not particularly oriented for temporal bone dissections.

It is very rewarding and less stressful if there is a set of data which gives estimated anatomical landmark distances when working with high-speed drills, which are used during mastoid exploration surgery. Aimed at this specific purpose of assisting a trainee ENT surgeon is not found in literature. The design of this study was to initiate a 'safe' atmosphere for the trainee to start drilling into the mastoid bone.

There is an array of drill-bit sizes to choose from during mastoid exploration. During the initial part of the dissection, an anteriorly placed sigmoid sinus or rarely a high jugular bulb may encounter unexpectedly. When drilling close to the linea temporalis inferior, middle fossa Dura may get exposed. In these critical instances, staying close to the bony canal wall and choosing a 40. mm size drill-bit may give an additional 'safety' feeling adding on to the anatomy knowledge as the study suggests a 4.0 mm safe distance. Even the sample size is small, the lack of many evidence in the literature is substantial given the context of live surgical dissection.

The lateral semicircular canal is more than 14.0 mm deep from the bony meatus. This is good rough estimate for the trainee when identifying structures when there is extensive pneumatisation of the mastoid bone or when there is a Körner's septum.

Knowledge of the detailed anatomy of the temporal bone is imperative before taking on any dissection. Research evidence from a case series sheds more light in the surgical perspective than supportive information from a text book. When there are many case series to analyze, the evidence becomes much stronger. Studies on living individuals are far more difficult to carryout than any cadaveric studies although both types of studies provide similar comparable information.

Key Messages

Anatomical data on mastoid bone dissection is not very common, but it is not very difficult to obtain. Record keeping of the data on the same operation note may assist retrospective studies and it does not require sophisticated equipment. Our interest has paved way for many improvements; still we can go that extra mile.

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Competing Interests

None.

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