



UMEÅ UNIVERSITET

Umeå University Medical Dissertations, New Series No 2013

---

# Malleus fracture

## Experimental and clinical aspects

**Anders Niklasson**

### Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av filosofie/medicine doktorsexamen framläggs till offentligt försvar i aulan Sunderby sjukhus fredagen den 29 mars, kl. 0900.

Avhandlingen kommer att försvaras på svenska.

Fakultetsopponent: Professor, Preben Homøe, Sjællands Universitetshospital, Køge, Danmark.

Clinical Science, Otorhinolaryngology

**Organization**

Umeå University  
Clinical science

**Document type**

Doctoral thesis

**Date of publication**

8 March 2019

**Author**

Anders Niklasson

**Title**

Malleus fracture, experimental and clinical aspects

**Abstract****Background**

Patients with malleus fractures are described as rare in the literature. The cause of these fractures are most commonly trauma and digital manipulation of the ear canal, while in some cases the causes are unknown. At our clinic we record one new case every year, which leads to an incidence of approximately 40-50 new cases every year in Sweden. Different treatments have been proposed for this condition. However, since the condition is rare, no consensus has been reached regarding the best treatment. Additionally, it remains unclear whether malleus fractures can heal.

**Aim**

To get a deeper understanding of how malleus fractures occur, how they should be treated surgically, and if the malleus shows any sign of bone healing.

**Materials and methods**

Paper I. We carried out both a retrospective study of the medical records of nine Swedish patients with isolated malleus fractures, and a literature review of this condition. Symptoms, clinical findings and patients' history were collected.

Paper II. Ossiculoplasty on human temporal bones was performed in the presence of a malleus fracture. We developed a surgical model from freshly frozen human temporal bones, and we performed Laser Doppler vibrometry (LDV) measurements on this model both before and after ossiculoplasty.

Paper III. We performed ossiculoplasties with different types of partial ossicular replacement prostheses (PORP) on human temporal bones and we measured the results with LDV.

Paper IV. We performed an *in vivo* animal study on Merino sheep, in which we produced isolated malleus fractures. We then compared the bone healing of these fractures with that of the nasal bone and the mandible. Bone healing was detected with micro-CT.

**Results**

Paper I. The most common cause of isolated malleus fractures was found to be a so-called "digital" trauma, which occurred when the patients had removed a finger from the wet ear canal after bath. The hearing loss was occasionally accompanied by tinnitus and transient pain. Pneumatic otoscopy and tympanometry showed a hypermobile tympanic membrane, while audiometry showed a conductive hearing loss that increased towards higher frequencies.

Paper II. Our LDV measurements indicated that fixation of an isolated malleus with bone cement may give the best results after surgery.

Paper III. The best LDV measurements were obtained when ossiculoplasty was done using a PORP in lateral contact with both the tympanic membrane and the malleus handle.

Paper IV. In our animal study we found no signs of bone healing at micro-CT four weeks after producing the malleus fractures. In contrast, both the nasal bone and the mandible showed bone healing. This indicates that the bone healing properties of the ossicles probably differ from those of other bones in the body.

**Conclusion**

Digital trauma is the major cause of isolated malleus fractures. Pneumatic otoscopy and tympanometry showed a hypermobile tympanic membrane, while audiometry showed a conductive hearing loss increasing towards the higher frequencies. We developed a method to employ freshly frozen human temporal bones and we used LDV for detecting optimal results. This method allows to evaluate and develop otosurgery, aimed to restore hearing after an interrupted ossicular chain. The animal study indicates that malleus fractures will not heal spontaneously.

**Keywords**

Malleus fracture, middle ear, conductive hearing loss, ossiculoplasty, human temporal bone, Laser doppler vibrometry, sheep animal model, ossicles, bone healing.

**Language**

English

**ISBN**

978-91-7855-021-0

**ISSN**

0346-6612

**Number of pages**

52 + 4 papers