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### *Incus subluxation and luxation during stapedectomy*

Otosclerosis is a disease of still unknown aetiology. Characteristic lesions are found with high resolution CT in about 10% of population with high predominance in women. Pathological changes are usually located in bony labyrinth and lead to stapes immobilization. The main symptoms are conductive hearing loss and tinnitus. The onset of the symptoms is usually in the third and fourth decade of life but otosclerosis can also be found in children (8). Hearing can be improved by surgical treatment. Stapedectomy or stapedotomy are procedures providing high success rate and few complications (2,3). However, the surgeon can encounter several problems during the operation.

The aim of the present study is to evaluate hearing results of stapedectomies complicated with incus luxation and to describe surgical technique used in these circumstances.

#### MATERIAL AND METHODS

Incus luxation occurred during 15 (5%) of 292 stapedectomies performed by the senior author between 1980 and 2001. The group included 6 females and 4 males, at the age of 21 to 65 years (mean  $36 \pm 10.2$ ). Patients' notes were reviewed for middle ear findings and management of incus luxation. Short-term results were available in all the patients and long-term results in 10 individuals.

All operations were performed under local anaesthesia with endoaural approach. A hole of about 1 mm was made in the footplate using hand perforator and 0.6 mm piston prosthesis was used in all the patients. Three different sequence of surgical steps were applied in the group (3). Pure-tone audiometry for bone and air conduction threshold was performed in all the patients at the frequencies 0.5, 1, 2, 3, 4 kHz. Two experienced technicians carried out hearing tests before, 8 (6–12) months and 10 (4–18) years after the operation. Patients' audiograms were analysed for pre- and postoperative air-bone gap (ABG) and postoperative air conduction (AC) improvement. Preoperative and postoperative air-bone gaps were calculated at 0.5, 1, 2, and 3 kHz according to Committee on Hearing and Equilibrium guidelines (7). The mean changes of BC, AC thresholds and ABG were analyzed statistically using t-Student test.

RESULTS

In 15 patients incus was unintentionally luxated. In one patient incus was completely dislocated and malleovestibulopexy with sculptured autoincus had to be applied. In 14 stapedectomies incus was subluxated and though it was pathologically mobile it was held in position by its ligaments. This situation allowed delicate reposition of the incus and insertion of the piston prosthesis on the long incus process. In 8 patients of the group middle ear abnormalities were found during the surgery. Facial nerve overhang obscuring stapes footplate was found in two patients and a shortened long process also in two patients. In 4 patients with incus subluxation the oval window niche was obliterated and required extensive drilling. In all 15 patients AC thresholds improved significantly at all the frequencies (Tab.1). Mean AC threshold

Table 1. Air conduction changes after stapedectomy with incus luxation in the group of 15 patients

dB kHz	Preoperative mean ± SD	Postoperative mean ± SD	Improvement mean ± SD	t-value	p<
0.5	59.7±9.9	30.3±12.7	29.3±15.2	7.46	0.0001
1	58.7±9.5	30.3±12.2	28.3±11.0	10.0	0.0001
2	56.3±13.7	27.0±11.8	29.3±9.4	12.1	0.0001
3	52.7±14.1	31.0±15.8	21.7±9.6	8.8	0.0001
4	51.7±14.7	40.0±17.5	11.7±13.6	3.3	0.01
Mean	55.8±9.8	31.7±12.2	24.1±8.4	11.1	0.0001

improved by 24 dB. Mean postoperative BC was also better by 2 dB than preoperative one. Postoperative ABG is the best indicator of successful ossicular chain reconstruction. Mean ABG improved from 34.6 ± 8.3 dB before to 13.1 ± 6.3 dB 8 months after stapedectomy. The difference was statistically significant (t=9.7; p<0.0001). Ten years after surgery average ABG was 10.6 ± 4.4 which means stable hearing result (Fig. 1). In 6 patients including the individual with complete incus luxation, postoperative ABG was less than 10 dB. In 9 patients postoperative ABG was between 10 and 15 dB.

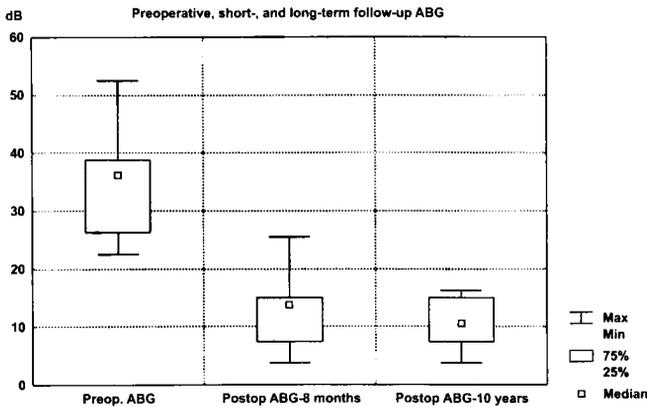


Fig.1. Box and Whisker plots showing air-bone gaps before, 8 months and 10 years after stapedectomy

## DISCUSSION

Incus and malleus have a fixed connection. Total luxation means disconnection of these ossicles and rupture of incus ligaments. This condition requires ossicular reconstruction or placing the prosthesis on the malleus handle. A minor injury is when the incus is disconnected from the malleus but its ligaments remain intact. This can be called subluxation or distortion. Because the ligaments keep the incus in place, the reposition of the incus and placing the prosthesis on the long process of the incus is possible. The malleus head gets fixed to incus and this enables good sound transmission. Similar management of incus subluxation was suggested by Causse (1). House (4) terminates the operation in case of incus subluxation and explores the ear in about 6 months after re-fixation of the ossicles. Incus can be dislocated during the removal of posterior bony overhang of the external acoustic meatus, during the removal of the stapes arch, or while inserting the prosthesis on the long process of the incus.

As reported by other authors, incus dislocation develops in about 2% of operations (4,5,6). The incidence of this complication may be connected with the type of prosthesis. Wire-Teflon prosthesis has its wire loop wide open and so it is more easily applicable than the Teflon one. The Teflon prosthesis is opened just before inserting it on the incus. When the loop of the prosthesis is not opened enough or it closes before it is inserted, some pressure has to be applied to place the prosthesis on the long process. This can cause subluxation or luxation of the incus.

In a previous study (3) we reported that incidence of incus luxation depended on the surgical technique used. Placing the prosthesis on the incus before removal of stapes arch prevented incus luxation.

## CONCLUSIONS

When the incus is subluxated good hearing results can be expected after inserting the prosthesis on the repositioned incus. Malleovestibulopexy should be performed in case of total incus luxation.

## REFERENCES

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## SUMMARY

Stapedectomy is a safe surgical procedure used in patients with otosclerosis. However, complications may occur and decrease hearing gain after the operation. The aim of the work was to analyze hearing results in patients with incus subluxation during stapedectomy. In 15 (5%) of 292 patients with otosclerosis, the incus was unintentionally luxated during surgery. In one patient the incus was completely dislocated and malleovestibulopexy with autoincus had to be applied. In 14 stapedectomies the incus was subluxated and though it was pathologically mobile it was held in position by its ligaments. This situation allowed delicate reposition of the incus and insertion of the piston prosthesis on the long incus process. Mean AC threshold improved by 24 dB. Mean ABG improved from  $34.6 \pm 8.3$  dB before to  $13.1 \pm 6.3$  dB 8 months after stapedectomy ( $t=9.7$ ;  $p<0.0001$ ). Ten years after surgery average ABG was  $10.6 \pm 4.4$ , which means stable hearing result. In 6 patients including the individual with complete incus luxation, postoperative ABG was less than 10 dB. In 9 patients postoperative ABG was between 10 and 15 dB. When the incus is subluxated good hearing results can be expected after insertion of the prosthesis on the repositioned incus.

## Podwichnięcie i zwichnięcie kowadełka podczas stapedektomii

Stapedektomia jest skuteczną i bezpieczną metodą poprawy słuchu u chorych na otosklerozę, jednak powikłania stwarzają trudności i mogą doprowadzić do pogorszenia słuchu. Celem pracy jest ocena wyników słuchowych w grupie 15 chorych, u których wystąpiło podwichnięcie kowadełka w trakcie stapedektomii. Podwichnięcie lub zwichnięcie kowadełka wystąpiło podczas 15 (5%) z 292 stapedektomii częściowych, przeprowadzonych przez jednego chirurga w latach 1980–2001. U jednego chorego, u którego doszło do całkowitego zwichnięcia kowadełka, wykonano maleovestibulopexję. U 14 chorych podwichnięte kowadełko delikatnie odprowadzono do prawidłowego ułożenia i nałożono protezę strzemiączka. U wszystkich 15 chorych wykazano istotną poprawę słuchu 6–12 (średnio 8) miesięcy po operacji. U 6 chorych, w tym u chorego z całkowitym zwichnięciem kowadełka, pooperacyjna rezerwa ślimakowa była mniejsza niż 10 dB, a u 9 chorych wynosiła 10–15 dB. Badania kontrolne w 4–18 (średnio 10) lat po operacji nie różniły się istotnie od badań wykonanych średnio 8 miesięcy po operacji. Repozycja podwichniętego kowadełka umożliwia dokończenie operacji i uzyskanie dobrego wyniku słuchowego.