



## Comparison of the effectiveness of teflon piston and titanium stapes prosthesis in hearing improvement

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### Abstract

**Background & objectives:** The aim of this study was to compare the effectiveness of two stapes prostheses in hearing improvement of patients undergoing stapes surgery for otosclerosis.

**Materials & Methods:** In this retrospective and descriptive study, the charts of 291 stapedectomies performed by one surgeon (first author) from 1997 to 2011 in Imam Khomeini and Apadana hospitals of Ahvaz were reviewed.

**Results:** A total of 278 patients, including 172 females (61.9%) and 106 males (38.1%) undergoing stapedectomy or Stapedotomy were evaluated in this study. Subjects were 18-69 years old with the mean age of 35.4 years. The study group was comprised of 32 titanium stapes prosthesis and 246 Teflon piston prostheses. Closure of the air-bone gap to less than 10 dB was achieved in 207 cases (84.1%) of the patients with Teflon piston prosthesis compared with 21 cases (65.6%) of those with titanium stapes prostheses. Deafness occurred in two patients (0.71%) after the surgery.

**Conclusions:** Both prostheses provided comparable results. The smaller numbers in the titanium group may confound these results. The selection bias may also influence the results seen in this study. The titanium stapes prosthesis is a good alternative to Teflon piston prosthesis.

**Keywords:** Otosclerosis; Stapedectomy; Stapes Teflon piston; Titanium stapes prosthesis; Ahvaz

### 1. Introduction

Otosclerosis is a disease of the otic capsule and middle ear ossicles. Otosclerosis is one of the most common causes of conductive hearing loss in people with 15-50 years of age<sup>1,3,6</sup>. Otosclerosis has been derived from a Greek word meaning ear hardening. Valsalva was the first to describe hearing loss due to stapes ankylosis in 1704. Otosclerosis is a hereditary disease which is

transmitted in an autosomal dominant form with incomplete penetrance<sup>2,4-6</sup>. Bilateral otosclerosis has been observed in 60% of patients<sup>3,6-7</sup>. Progressive and conductive hearing loss particularly at low frequencies (500-2000 Hz) which may sometimes occur with sensorineural hearing loss has been identified as the main clinical finding of Otosclerosis<sup>8</sup>. There is not any definitive medical treatment for the disease; however, some surgical methods such as

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Stapedectomy or stapedotomy may be effective in the treatment of hearing loss. Stapedectomy includes removal of the stapes, creating a small bone in the footplate and inserting the prosthesis between the Incus and the oval window<sup>3,9</sup>. The era of modern stapes surgery began in 1956, when Shea successfully removed the stapes and reconstructed the ossicular chain with a Teflon prosthesis after sealing the oval window with a thin skin graft. In 1958, Shea presented a technical note of stapedectomy, where the oval window was sealed with vein graft and reconstruction was performed with the posterior crus of stapes or with a polyethylene tube<sup>10-11</sup>. This new state-of-the-art reconstruction of the ossicular chain was found to be far superior to the former mobilization operations, and thus, became the standard. Many modifications of stapedectomy have been developed using different sealing materials such as fat, fascia, gelatin foam and perichondrium, and the prosthesis has been constructed with such material as steel, tantalum, platinum and bone<sup>12-13</sup>. The fenestration of the oval window had also been evolved. Partial stapedectomy was suggested by Plester to diminish inner ear irritation, and by the 1960s small-opening stapedotomy was also introduced for the same reason. Both techniques, total removal of the footplate (stapedectomy) and small-opening stapedotomy, are still in use and have proven successful in the long-term restoration of hearing<sup>14</sup>. In this study Titanium and Teflon piston stapes prostheses were compared with regard to effectiveness in closing the air-bone gap in otosclerotic patients referred to Imam Khomeini and Apadana hospitals of Ahvaz.

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## 2. Materials and Methods

In this retrospective and descriptive study, a total of 291 stapedectomies, which were performed by one surgeon (first author) from 1997 to 2011 in Imam Khomeini and Apadana hospitals of Ahvaz, was reviewed. Patients who underwent stapedectomy for reasons other than otosclerosis, revision cases, and those with inadequate preoperative or postoperative bone-conduction threshold data were excluded. A Small

fenestra technique using either laser or drill was used for all patients. Complete Stapedectomy includes complete removal of the foot plate of stapes; incomplete Stapedectomy is the removal of a third of the foot plate of stapes whereas Stapedotomy is creating a small opening (0.4 to 0.8mm in diameter) in the foot plate of stapes. The Inclusion criteria were met by 278 patients. Patients were then grouped according to the type of prosthesis used, and hearing outcomes were compared. Measured outcomes were four frequency air-bone gap (500,100,2000,4000) closure, pure-tone threshold, and rate of sensorineural hearing loss (SNHL). For all of the patients thorough history and physical examination in addition to audiologic studies before and 2 months after surgery will be recorded.

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## Statistical analysis

The obtained data were analyzed by SPSS16. One sample T-test was applied to compare the means and ANOVA test was used for comparison between groups. A P-value less than equal to 0.05 was considered as significant.

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## 3. Results

In this study 278 patients including 172 females (61.9 %) and 106 males (38.1%) undergoing stapedectomy or stapedotomy were evaluated. Subjects were 18-69 years old with the mean age of 35.4 years. 181 patients (65.1%) were in the age range of 30-40 years. Unilateral ear involvement was revealed in 188 patients (67.6%) and bilateral involvement in 90 (32.4%). Surgery on the right ear was reported in 179 (64.3%) and on the left ear in the 99 cases (35.7%).

The study group was comprised of 32 titanium and 246 Teflon piston prostheses. Closure of the air-bone gap to less than 10 dB was achieved in 207 cases (84.1%) of the patients with Teflon piston prosthesis compared with 21 cases (65.6%) of those with titanium prostheses (Table1). Deafness occurred in two patients (0.71%) after the surgery.

**Table 1. Hearing improvement following Teflon piston and Titanium stapes prostheses**

Prosthesis	Frequency (Hz)			
	500	1000	2000	4000
Teflon piston (246)	86.2%	85.8%	84.1%	80.9%
Titanium (32)	75%	68.8%	65.6%	53.1%

#### 4. Discussion

Otosclerosis is one of the most common diseases involving the ear capsule. This disease occurs only in humans and is more common in middle aged women<sup>15</sup>. Otosclerosis has been diagnosed as the most common cause of conductive hearing loss. It may even progress in to permanent deafness. Stapedectomy is an elective surgery, affecting the patient and his or her relatives' quality of life. Surgeon's experience plays an important role in performing this delicate type of surgery on the stapes<sup>16</sup>. The surgical treatment of otosclerosis has evolved greatly since the first successful fenestration of the oval window and reconstruction of the ossicular chain with an artificial material in 1956. During the ensuing decades, less traumatic operative techniques have been developed to minimize the risk of inner ear trauma<sup>13,17</sup>. Prosthesis materials that are easier to handle and that have better biocompatibility have been introduced, the latest having "memory" enabling the surgeon to crimp the prosthesis without touching it. A Small-opening stapedotomy using a laser or micro-drill has become more popular than stapedectomy, in which the stapes footplate is removed either partially or totally. Different sealants made of either autologous or artificial material have been introduced. Massey<sup>18</sup> showed that closure of the air-bone gap to less than 10 dB was achieved in 86% of the patients with Teflon piston prosthesis compared with 71% of those with titanium stapes prostheses. Lippy<sup>19</sup> said that there was no significant difference between titanium piston stapes prosthesis and a Robinson stainless steel piston in hearing improvement or postoperative air-bone gap. The mean four-frequency hearing improvement was 27.7 dB for the stainless steel group and 27.8 dB for the titanium group. Raske<sup>20</sup>

had a failure of their initial air-bone gap closure with the McGee piston 11.2% of patients over a 10-year period. In our study group was comprised of 32 titanium stapes prosthesis and 246 Teflon piston prostheses. Closure of the air-bone gap to less than 10 dB was achieved in 84.1% of the patients with Teflon piston prosthesis compared with 65.6% of those with titanium stapes prostheses.

#### 5. Conclusion

The results showed that both prostheses provided comparable results. The smaller numbers in the titanium group may confound these results. The selection bias may also influence the results seen in this study. The titanium stapes prosthesis is a good alternative to Teflon piston prosthesis. Source of funding: This trial was supported by Grant from the research deputy of Ahvaz Jundishapur University of Medical Sciences, Iran.

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