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The history of the tenotomy of the middle ear muscles*

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Introduction

In the time of Hippocrates there existed already the fear of wounds and injuries to tendons as they could often be fatal. A well-known example is the Achilles tendon. According to the well-known anatomist Joseph Hyrtl (1810-1894) from Vienna, this was the reason that a tendon section (tenotomy) was not being used until the 19th century. He also stated that by this fear the incision of tendons in long-lasting or permanent contraction and stiffness of the muscles was introduced only as last resort option. In 1857, Hyrtl (fig.1) extensively described the anatomy of the middle ear musculature and suggested in certain cases to cut the tendon of '*Der Spanner des Trommelfells*'.[1] Cutting the m. tensor tympani would remove excess tension on the eardrum, resulting in a better hearing for the high and the soft tones. This announcement was picked up by Dr.Weber-Liel from Berlin.

Friedrich Eugen Weber-Liel (1832-1891)

Friedrich Eugen Weber-Liel was born on October 19, 1832 and became a physician in 1858. He was one of the first to practice ear surgery in Berlin. In 1872 Weber-Liel was appointed as a staff doctor in the Berlin University Clinic who only dealt with ear medicine. Weber-Liel founded the "*Monatsschrift für Ohrenheilkunde*" in collaboration with Voltolini, Gruber and Ruedinger in 1867 and has made a name for himself by cutting the tensor tympani muscle which he has done for the first time to cure certain cases of deafness. In 1873 Weber-Liel published his only book entitled : „*Ueber das Wesen und die Heilbarkeit der häufigsten Form progressiver Schwerhörigkeit. Untersuchungen und Beobachtungen*"[2] in which he discussed in detail the dysmotility of the pharyngeal tube muscles in their significance for the development of progressive deafness. In 1884 Weber-Liel accepted the position of an associate professor in Jena. Only a year later he had to put down this position in 1885 for health reasons and

Fig.1.
Joseph Hyrtl (1810-1894)

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moved first to Wiesbaden, later to Bonn, where he died on November 30, 1891.

Tenotomy of Tensor tympani

Inspired by the work of Hyrtl Weber-Liel started around 1868 as one of the first with the tenotomy of the tensor tympani as a treatment for hearing impairment and ringing in the ears. In 1874 he dared to publish his first results of the new operation.[3] In his publication Weber-Liel referred to the studies by Politzer and von Tröltsch, who also pointed to an abnormally strong tensor tympani as the cause of ear complaints and tinnitus. After exercise on 38 fresh temporal bones (fig.2), Weber-Liel started with the intervention on patients. He described his surgery very carefully. According to him, it was not necessary to give the patient an anesthetic before the operation. The patient placed his head in a specially designed headrest with a clamp that pulled the earlobe, so that the ear

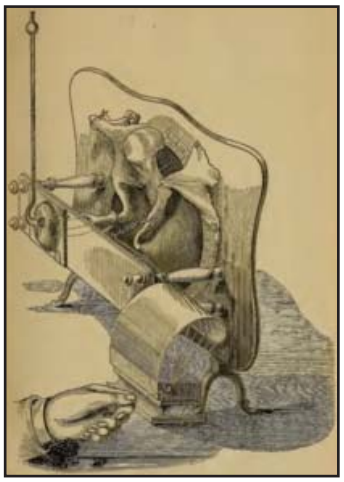

Fig.2
Test set for middle ear research by Weber-Liel 1873

canal opened and the eardrum became visible. After proper exposure and local anesthesia with cocaine, a few millimeters in front of and under the processus brevus of the malleus handle an incision in the tympanic membrane was made with a specially designed tenotome. A '*Hackenmesserchen*' (fig.3) was then introduced through the opening, and the tendon of the tensor tympani was sectioned on feeling with a slight twisting movement and light pressure. Weber-Liel noted that the surgeon often heard a crackling sound at that moment. The removal of the hook knife had to be quiet and careful otherwise the eardrum and the chain could be da-

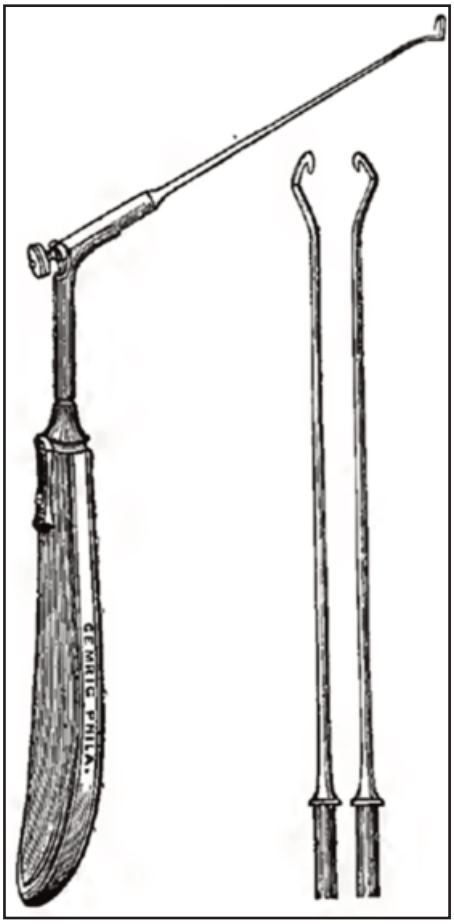

Fig.3
A tenotome ('Hackenmesserchen') according to Weber-Liel. For right and left ear.

maged. The patient could feel some pain during the procedure. The perforation made would completely heal within 3 to 6 days. At the time of his first publication, 188 patients (225 ears) had been treated by Weber-Liel. The results of 74 patients (86 ears) were superficially explained. The follow-up time was 6 to 8 months. He stated that the ringing in the ears and the dizziness complaints had almost disappeared and that the hearing was normalized. Weber-Liel ended his publication as follows: "*Die Tenotomie auch von denen, welche ihr jetzt noch widerstreben sollten, als die bedeutendste therapeutische Errungenschaft auf dem Gebiete der Ohrenheilkunde der Neuzeit anerkannt werden wird.*"

The popularity of the tenotomy

The operation of Weber-Liel soon had many followers. Joseph Gruber (1827-1900) (fig.4) from Vienna was one of the first to start applying the tenotomy after Weber-Liel. In 1875 he even claimed that he performed the surgery earlier than Weber-Liel. That could be true because he worked in Vienna and certainly knew the famous anatomist Joseph Hyrtl, who advised the tenotomy treatment.

Fig.4
Joseph Gruber (1827-1900)

Gruber, of course, developed his own instruments for the tenotomy and modified the procedure by an incision of the eardrum behind the long process of the malleus instead in front of it. Arthur Hartmann (1849-1931) from Berlin, after experimenting with the tenotome of Gruber in collaboration with Politzer, developed his own modification of the tenotome for the operation dorsal of the malleus.[4] In 1875 Weber-Liel gave a lecture in Graz where he discussed the results of his tenotomy.[5] He had done over more than 300 operations so far and the results were particularly good. Hearing disorders accompanied by dizziness would completely disappear and thereby the ringing of the ears would also become considerably less and sometimes disappear altogether. It was noted that the nice result was often only temporary. During the discussion after the presentation, Weber-Liel answered to the comments of Johannes Kessel (his later successor in Jena) that his objections to the intervention were only of a theoretical nature. The indications for the procedure were not yet clear at that time. However, it was the practical experience that counted the most for Weber-Liel. Kessel stated that it was of great importance to test the hearing with the tuning fork first to confirm perceptive hearing, otherwise the intervention would not be successful. In the same discussion, Gruber argued that diminishing dizziness and ringing in the ears was the main goal of the tenotomy of the tensor tympani. An improvement in hearing came only second to him. The intervention was also received enthusiastically outside Germany and Austria. In America, the intervention was introduced by Oren Pomeroy from New York[6] and Orne Green from Boston. They used Gruber's modified technique, whereby the incision was placed just behind the malleus handle and they argued that on the basis of the following remarks. In the case of a narrow auditory canal, it was impossible to make a paracentesis in front of the malleus handle. Lawrence Turnbull from Philadelphia, on the other hand, used the method of Weber-Liel.[7] In France, Camille Miot from Paris first introduced the tenotomy in 1878, after the Hungarian physician Lichtember had translated the German publications for him.[8] Miot described the operation in detail, in which the anesthesia, the lighting and the instruments needed for the success of the intervention were discussed in detail. The incision for the tenotomy was cranial of the malleus (fig.5). Miot also described the possible complications of the operation, such as a bleeding from the paracentesis, pain after the procedure, a middle ear infection and very rarely deafness. The follow-up treatment by Miot consisted in some cases of the Valsalva manoeuvre and an intra tympanal injection with a solution of 'chlorhydrate d'amoniaque ou potasse caustique' for at least 15 to 20 days twice a week. Finally, Miot performed 29 tenotomies of the tensor tympani. In 27 of these patients the procedure was more or less successful. It was remarkably that Miot found that in a number of patients the nocturnal tinnitus was reduced or even disappeared. Whether the result was of a lasting nature was not mentioned.

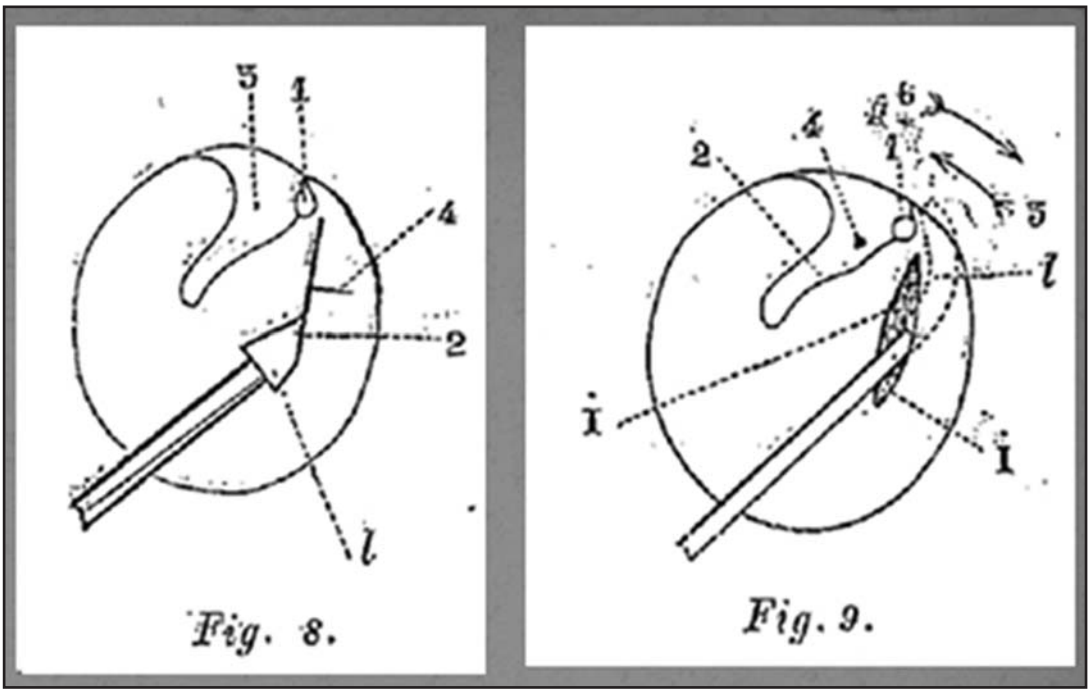

Fig.5 Tenotomy described by Camille Miot 1878

Reflections on the tenotomy

In 1876, the famous otologist Hermann Schwartze (1837-1910) from Halle (fig.6) published his experiences with the tenotomy of the tensor tympani.[9] It is interesting to see that there was a considerable rivalry between the different ear doctors of that time. Schwartze claimed just like Gruber that he had practiced the tenotomy of the tensor tympani experimentally on temporal bones as well as on patients long before Weber-Liel. Naturally Schwartze also described a tenotome designed by himself. He concluded, however, that he had not obtained a lasting favorable result in any of the patients who had a tenotomy. Schwartze also explained this the reason why he had not communicated earlier about his experiences with the tenotomy. Although Schwartze himself had not had any complications from the tenotomy, it was known to him that the intervention by other colleagues sometimes led to a considerable hearing loss and an increase in the tinnitus. Because of his experiences with the tenotomy of the tensor tympani, he was convinced that this type of ear surgery would no longer have a future. The claimed success of the tenotomy of the tensor tympani by Weber-Liel, Gruber, Frank ("*Mit der Tenotomy des Trommelfellspanners feiert operative Otiatrie ihre schönsten Triumphe*"[10]) and Urbantschitsch, was not shared by von Tröltsch, Schwartze and Politzer . For example, in the textbook of Politzer from 1878 a chapter is devoted to the tenotomy of the tensor tympani, in which Politzer states that the result of the intervention by adhesion formation is often nullified and that a simple paracentesis would often have the same result as the tenotomy.[11] Politzer was very critical of the operation when he wrote: "*Die tenotomie des tensor tympanie gehört daher zu jenen operations, welche nicht nur einen geringen Nutzen gewähren sondern auch manchmal einen deletären einfluss auf die hörfunktion üben* ". The initial enthusiasm for the tenotomy clearly declined in the 1890s. For exam-

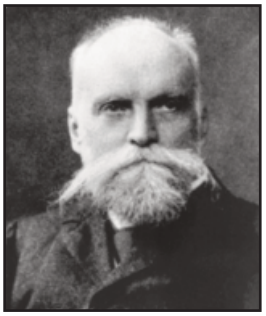

Fig.6
Hermann Schwartze
(1837-1910)

ples Bürkner (1882) noted that there were still many doubts about the success of the tenotomy [10].. In his textbook '*Die chirurgischen Krankheiten des Ohres*' (1885) Schwartze repeated his remark of 10 years before, namely that the tenotomy of the tensor tympani did not produce a lasting result in any case. He quotes Politzer who wrote earlier that he saw several patients from other colleagues, in whom the tenotomy eventually led to irreparable deafness [12].

Tenotomy in Jena's Ear Clinic

In the ear clinic in Jena, however, the belief in the intervention remained clear despite the criticism of the well-known otologists of that time.Friedrich Eugen Weber-Liel from Berlin, known as the inventor of the tenotomy of tensor tympani, accepted the extraordinary professorship in Jena in 1884. After a year, however, he had to give up this office for health reasons and was succeeded by Johannes Kessel who came over from Graz. Kessel had performed with Ernst Mach the function of the middle ear muscles[14] and he was the first to have performed a stapes extraction in a patient in 1876. The tenotomy had become a known intervention in Jena and Kessel continued this tradition, although in the past he had commented on the indication for the procedure. In 1891 Kessel published an overview of the tenotomy of the tensor tympani[15]. The success of the intervention depended on the situation of the stapes. If this was fixed, then no success of the tenotomy could be expected, according to Kessel. In the case of tinnitus based on an increased pressure in the inner ear due to cramping of the tympanic muscles, it would be possible to expect success of an early tenotomy with a consequent improvement in auditory acuity and reduction in tinnitus. In one case even the hallucinations of a patient disappeared after the tenotomy! Kessel used the approach via the upper anterior quadrant of the eardrum because this approach was the easiest for him. However, the chorda tympani could unfortunately died during the procedure, but according to Kessel the taste disturbance quickly recovered. The ear clinic in Jena was very active in applying the tenotomy. For example, in 1891 the assistant Muller describes the importance of the intervention in the treatment of eardrum perforations (one of the indications by Kessel)[16] Nine patients were presented and the result in eardrum perforations was that the running ears had disappeared due to the tenotomy. The hearing measured by the whisper speech would have improved well in six out of nine patients. Three years later (1894) Hoffmann[17] also from the Kessel clinic, published a positive paper claiming that constant cramp of the tensor tympani muscle would also cause changes in the malleus-incus joint (ankylosis), which would then give mechanical changes at the level of the stapes footplate with a fixation of the stapes as a result. Due to the cramping condition of the tensor tympani, the pressure on the perilymph in the inner ear would also increase via the ossicular chain. This would result in a perceptive hearing loss in addition to a loss of conduction. For Hofmann it was clear that the cutting tensor tympani in eardrum perforations with chronic middle ear infections was the treatment of choice as drug therapy alone was not sufficient.

The end of the middle ear surgery

Politzer had already expressed his reservations about ear operations on the stapes and the utility of the tenotomy. During the 6th International Otology Congress (1899) in London there was a discussion with Politzer about the stapes extraction as a hearing improving intervention. August Lucae (1835-1911) from Berlin (a former colleague of Weber-Liel) reported a tragic case in which the stapes was only mobilized by the resident in a fully healthy young man during the ear operation.[18] Postoperative meningitis occurred, causing the patient death. This incident was included in the later discussions about the middle ear operations of that time. In 1900 during the otology section of the 13th International Medical Congress in Paris Ricardo Botey (1855-1927) from Barcelona put ten points forward leading to the conclusion that middle ear surgery and especially the stapes extraction were completely useless and could also be dangerous.[19] Friedrich Siebenmann (1855-1921) from Basel supported the views of Botey and the middle ear surgery was banned[20]. Since then, the tenotomy of the middle ear muscles has disappeared as treatment for hearing loss and tinnitus. A casuistic communication appeared in 1949 by Taylor and Batemann who published a case of improved hearing of a tenotomy of the sta-

pedius muscle (they called it a Stapediotomy) after the ear was cured of a chronic otitis [21] They had noticed that the tendon of the steps was rather tough and that it was difficult to cut it with their furness myringotome. In 1951 Bruining published also a case of a tenotomy of the musculus stapedius.[22] On the basis of the otoscopic image (a tightly stretched white string) it was assumed that due to previous infections the stapes tendon had been fixed. The tenotomy resulted in hearing improvement.As part of the stapectomy for otosclerosis, the tenotomy of the musculus stapedius was reintroduced in 1956 and this is now almost a standard part of this procedure.[23]

The tenotomy of the tensor tympani in the 21st century

Nowadays there seems to be interest again in the tenotomy of the middle ear muscles as a treatment of Ménière's disease and tinnitus. In 2003 Franz and his colleagues from Vienna treated patients with Ménière's disease[24]. After a careful 'work-up' the indication was given for a section of the tensor tympani muscle and the tendon of the stapedius muscle. The result of the study was that a tenotomy of the middle ear muscles was a successful treatment for the symptoms of Ménière's disease and that this treatment would have a long-term positive effect. The authors regarded their surgical tenotomy procedure for Ménière's disease as a promising treatment for the future.In 2009 De Valck et al published the results of sectioning of the tensor tympani with intratympanal gentamicin application[25].The conclusion of this study was that the tenotomy of the middle ear muscles had no additional value in the treatment of Ménière disease. Hadaka et al.(2013) reported favourable results from selective cutting of the tensor tympani in cases of a middle ear myoclonus.[26] They described a case report and also performed a meta-analysis. The outcome was that a selective tenotomy is not a complete solution for tinnitus. Furthermore, they argued that clear indications should be developed for the selective tenotomy. In that respect it seems that one is back to the level of the late 19th century. The recent positive results published by Loader et al [27,28] of the HNO clinic in Vienna must certainly be judged with some reservations given the presented history of the intervention in this paper. It is questionable whether the tenotomy of the tensor tympani will return again as treatment after more than a century of absence as a regular intervention in ear surgery.

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