ENDOLYMPHATIC SAC SURGERY AND POSTERIOR SEMICIRCULAR CANAL FENESTRATION FOR MENIERE'S DISEASE

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ABSTRACT

Objective: To evaluate the efficiency and safety of the simultaneous endolymphatic sac drainage (ELSD) and posterior semicircular canal fenestration (PSCF) primary on the vestibular function as a new therapeutic strategy in the patients with medically refractory Meniere's disease (MD).

Study Design: retrospective follow-up study.

Setting: University Clinic of Otolaryngology.

Methods: Twenty-six patients with MD with severe vertigo and disability who underwent ELSD and PSCF in the same time in the period of 1988 and 2007 were reviewed. The main outcome measures were frequency of vertigo, functional disability according the guidelines for diagnosis and evaluation of therapy in MD. The canal paresis was evaluated by caloric test. The degree of reduced vestibular response rates as an indicators of the vestibular function were compared before and after surgery.

Results: The preoperative audition was already altered in all cases except in 8 patients who had no significant changes in hearing threshold. The mean value of vertigo attacks before operation was 8.6. After 3 years of surgery only one patient (3.8%) had one vertigo attack. Functional level was highly ameliorated except in two patients who presented functional level 2 or B in the late postoperative period. The mean caloric testing duration after 3 years postoperatively showed that the 50% of the patients approaching the normal results.

Conclusion: Based on the results of simultaneous endolymphatic sac surgery and posterior canal fenestration, they are effective methods for treatment of the refractory Meniere's disease. Endolymphatic sac surgery enables drainage of endolymphatic fluid and the fenestration of the posterior semicircular canal enables the distension or dilatation of the membranous canal in the decompressed perilymphatic space across the perilymphatic leak at the level of the new fenestra, and, so, appearing of certain decrease of the endolymphatic pressure. Both techniques at the same time decrease the pressure in the case of the endolymphatic hydrops.

Keywords: Meniere's disease, refractory vertigo, endolymphatic sac surgery, posterior semicircular canal fenestration

INTRODUCTION

Few procedures in otological surgery have been as controversial as endolymphatic sac surgery for Meniere's disease. Opinions regarding

the efficacy of this procedure vary from those who conclude that the procedure is effective in over 80% of cases to those who believe that the

procedure is not better than a placebo or sham procedure [1, 2]. Despite this controversy, most clinicians recommend endolymphatic sac surgery because it is a nondestructive procedure that can be performed as an outpatient basis [3, 5]. Endolymphatic sac procedure offers the possibility of vertigo control with little risk of morbidity. Theoretically, endolymphatic sac surgery offers improves the function of a scarified endolymphatic sac or opens a blocked endolymphatic duct. Consequently, the pressure of the endolymph in the endolymphatic space is thought to decrease.

Recently, another type of surgical method has been developed for control of vertigo in Meniere's disease: the semicircular canal plugging, which aims to ablate endolymphatic movement in the occluded canal [6]. Several studies suggest that this method should be one of the therapeutic option for intractable vertigo in Meniere's disease [7, 8].

In this study, we examined the simultaneous effects of posterior semicircular canal fenestration and endolymphatic sac drainage primary on vestibular and cochlear function as a new therapeutic strategy for disabling Meniere's disease.

MATERIALS AND METHODS

This study revealed twenty-six patients with debilitating vertigo symptoms who underwent simultaneous endolymphatic sac surgery (ELSD) and fenestration of the posterior semicircular canal (PSCF) at the University Clinic of Otolaryngology, Medical faculty Skopje, between 1988 and 2007. All patients met criteria for definite Meniere's disease as established by the American Academy of Otolaryngology-Head and Neck Surgery criteria [9, 10]. The diagnosis of the Meniere's disease was based on a careful history, including a neurotologic history and physical examination, audiometry, vestibular testing, laboratory testing, and imaging methods. In all patients, the appropriate medical management with diet, diuretics, vestibular suppressants, steroids or vasoactive agents has failed to control the vertigo attacks, and all of them chose and decided to have a surgical treatment. Every patient was informed carefully about the surgical and functional risks and also about the other options of surgical treatments.

Main outcome Measures

Hearing

Hearing level was documented by audiometry. The mean sensory-neural hearing loss (SNHL) was quantified using the formula: SNHL (dB) = (2x hearing loss at 1kHz + 4 x hearing loss at 2 kHz + 1x hearing loss at 4kHz).

Vestibular function

The vestibular function was assessed through the frequency of vertigo, functional disability and caloric test.

Frequency of vertigo – FV

The frequency of vertigo attacks before surgery has been compared with the frequency of the attacks occurring between 6 and 36 months after the surgery. The vertigo control was established according the criteria of AAO-HNS, using the formula:

Y-FV – is the average number of definitive spells per month for six months before therapy

X – FV – is the average number of definitive spells per month for 18 to 36 months after therapy

Results:

$(X/Y) \times 100$

The results have been noted on a scale of A (complete control) to F (no control) [10].

Functional disability

The functional disability was self-assessed by the patients before and after the surgery on a scale of 1 (no disability) to 6 (permanent disability) according to the criteria of modified version of the AAO- HNS functional scale [10].

Caloric test

The vestibular function was assessed with caloric test. All the patients included in this study had both preoperative and postoperative caloric testing. The caloric test procedure consisted of standard bithermal irrigation.

Statistics

Categorical variables are present with absolute and relative numbers. Descriptive statistics for continual variables are calculating the mean values, standard deviation (SD), standard error (SE) median, minimal and maximal values.

Statistical analysis has been done with the following tests: Wilcoxon Matched Paris test, t test for dependent samples. For the level of significance was used $p < 0.05$.

Surgical Procedures

The ELSD and PSCF surgery was performed under general anesthesia with retro-auricular approach by the senior author of the study. Our technique involved limited antro-mastoidectomy and facial and posterior semicircular canal identification, followed by skeletonization of the posterior fossa dura and complete decompression of the sac. Maximum bone removal in the infra-labyrinthine compartment was stressed. The lateral aspect of the sac was incised, and the sac and duct were probed. A thin Silastic sheet was placed into the sac extending into the mastoid cavity. A subarachnoid shunt was employed in two patients.

The second surgery step was drilled around the dome of the posterior semicircular canal with a small diamond burr and isolating the dome at about 2.5 x 5 mm up to the blue line. After the blue line was visible, the dome was removed,

as an eggshell would be, with a sickle knife and without injuring the membranous labyrinthine. The fenestra and surrounding bone were covered with a piece of skin graft. The osteogenesis-inhibitory effect of the squamous epithelium is well understood in the cholesteatoma, and we used this to inhibit neo-osteogenesis on the fenestration site. The incision closure and postoperative early follow-up were standard.

RESULTS

The patients group included 17 men and 9 women. The age range of the patients who underwent surgery was 27 to 59 years (mean 45.7 years). The average number of years from the onset of symptoms until the time of surgery was four years (3 to 6 years). The initial symptom in 14 patients was violent whirling vertigo. Tinnitus of a low frequency type and a fluctuating hearing loss accounted for the main complaint in the remaining 12 patients. The seventeen surgical procedures were on the right, and another 9 on the left ear. There were no surgical complications.

Table 1. *Frequency of vertigo*

Number of vertigo attacks	6 months before operation		6 months after operation		3 years after operation	
	N	%	N	%	N	%
0	/	/	21	80.8	23	88.5
1	/	/	1	3.8	2	7.7
2	/	/	2	7.7	1	3.8
3	/	/	2	7.7	/	/
4	2	7.7	/	/	/	/
5	5	19.3	/	/	/	/
7	3	11.5	/	/	/	/
8	7	26.9	/	/	/	/
9	1	3.8	/	/	/	/
10	5	19.3	/	/	/	/
12	1	3.8	/	/	/	/
15	2	7.7	/	/	/	/
total	26	100	26	100	26	100

6 months before/6 months after – Wilcoxon Matched Pairs $Z=4.46$ $p=0.000008$ ($p<0.001$)

6 months after/3 years after according to Wilcoxon Matched Pairs $Z=1.62$ $p=0.11$ NS

Hearing

The preoperative audition was already altered in all cases. The audiometric evaluation of our study group gave the following results: in 10 patients (38.5%) a recovery greater than 10db was registered, another seven patients (27%) experienced hearing threshold worsening greater than 10db and 8 patients (30.7%) had no significant hearing threshold changes. Only one case of postoperative deafness was noticed (3.8%).

Vestibular function

Frequency of vertigo

The results for the frequency of vertigo are presented in Table 1 and Figure 1.

According to the results, there is evidently a high statistical significance in reducing the vertigo attacks frequency after 6 months postoperatively, while in the period from 6 months to 3 years, the differences in the frequency of the vertigo attacks show a low statistical significance.

Functional level

The preoperative functional level confirmed severe stage of the disease in all cases. After the surgery the functional level was highly ameliorated, except in 6 patients who presented functional level 2 in the early postoperative period. After the period of 3 years only 2 patients (7.7%) presented functional level 2 or B. Another 24 patients (92.3%) were completely asymptomatic (level 1).

The results show significant improving of the functional level in the first 6 months postoperatively. Improving of the function level in

the period from 6 months to 3 years was not of statistical significance.

Caloric testing

After endolymphatic sac surgery and fenestration of the posterior canal the patients presented decrease of the canal paresis.

Table 3 shows the distribution (absolute and relative) of the caloric testing duration among the patients at three time-points: preoperatively, 6 months and 3 years after surgery.

Tables 3, 3.1, 4, and 4.1 present the descriptive data of the mean caloric test duration by calculating the mean values (mean), standard deviation (SD), lowest and highest duration, as well as median value (median).

The average caloric testing duration is 78.0 ± 8.6 sec preoperatively, 85.8 ± 14.2 sec, 6 months and 93.8 ± 13.2 sec postoperatively. The minimal test duration is ranging from 60 sec preoperatively and 6 months postoperatively till 70 sec, 3 years post operatively. The maximal test duration is ranging from 90 sec preoperatively till 110 sec at the control testing 6 months and 3 years postoperatively. The mean testing duration shows that 50% of the patients had caloric test duration longer than 80 sec preoperatively, 90 sec 6 months, and 100 sec, 3 years postoperatively (approaching the normal results).

The tested differences between the average caloric test duration analyzed preoperatively, 6 months and 3 years postoperatively, show high statistical significance ($p < 0.01$).

Fig.1 Average number of vertigo attacks

Table 2. Functional level 6 months before operation, 6 months and 3 years after operation

FL	6 months before operation		6 months after operation		3 years after operation	
	N	%	N	%	N	%
1	/	/	20	76.9	24	92.3
2	/	/	6	23.1	2	7.7
5	20	76.9	/	/	/	/
6	6	23.1	/	/	/	/
Total	26	100	26	100	26	100

6 months before/6 months after operation – Wilcoxon Matched Pairs $Z=4.46$ $p=0.000008$ ($p<0.001$)

6 months after/3 years after operation – Wilcoxon Matched Pairs $Z=1.83$ $p=0.068$ NS

Fig. 2. Functional level of vertigo attacks**Table 3.** Results from the caloric test with cold water before, early and late postoperative

Caloric test (sec) - Cold water	Before operation		6 months postoperative		3 years postoperative	
	N	%	N	%	N	%
60	2	7.69	2	7.69	0	0
70	6	23.08	5	19.23	3	11.54
80	12	46.15	5	19.23	4	15.38
85	1	3.85	0	0	0	0
90	5	19.23	5	19.23	5	19.23
100	0	0	8	30.77	8	30.77
110	0	0	1	3.85	6	23.08
Total	26	100	26	100	26	100

Table 3-1. Mean, standard deviation, standard error, median, minimum and maximum values before, early and late after operation

Caloric test (sec)- cold water	N	Mean	SD	SE	Median	Min.	Max.
Before operation	26	78.27	8.6	1.7	80.0	60.0	90.0
6 months postoperative	26	85.77	14.2	2.8	90.0	60.0	110.0
3 years. postoperative	26	93.85	13.2	2.6	100.0	70.0	110.0
t-test for dependent samples							
Before operation / 6 months after operation					t=3,4	p=0.0023	Sig.
Before operation/ 6 after operation / 3 years after operation					t=5,5	p=0.00001	Sig.

Table 4. Results from the caloric test with warm water before, early and late postoperative

Caloric test (sec)- Warm water	Before operation		6 months postoperative		3 years postoperative	
	N	%	N	%	N	%
50	2	7.69	0	0	0	0
55	1	3.85	0	0	0	0
60	11	42.31	3	11.54	0	0
70	7	26.92	12	46.15	7	26.92
80	4	15.38	7	26.92	11	42.31
90	1	3.85	3	11.54	6	23.08
100	0	0	1	3.85	2	7.69
Total	26	100	26	100	26	100

Table 4-1. Mean, standard deviation, standard error, median, minimum and maximum duration before, early and late postoperative

Caloric test (sec)- Warm water	N	Mean	SD	SE	Median	Min.	Max.
Before operation	26	65.96	10.0	1.9	60.0	50.0	90.0
6 months postoperative	26	75.00	9.9	1.9	70.0	60.0	100.0
3 years postoperative	26	81.15	9.1	1.8	80.0	70.0	100.0
t-test for dependent samples							
Before operation/ 6 months after operation					t=4.7	p=0.00008	Sig.
6 months and 3 years after operation					t=3.49	p=0.0018	Sig.

DISCUSSION

Having stated that the exact etiology is unknown, what do we know of the Meniere's disease? Meniere's disease is a clinical disorder associated with the histopathological finding of endolymphatic hydrops [11, 12]. Many procedures have been designed for this condition for mechanical decompression of the endolymphatic space, including the Fick procedure, the Cody tack, cryosurgery, ultrasound, and otic-periotic shunt [15, 17]. The one procedure that seems to have best survived the test of time despite controversy, however, is the endolymphatic sac decompression/drainage technique. However, the natural history of the Meniere's disease, specifically the spontaneous remission rate and the high placebo effect seen in Meniere's patients, has provoked many to question the effectiveness of endolymphatic sac procedures. Despite the con-

troversies beliefs concerning the benefits of the endolymphatic sac surgery in Meniere's disease with serviceable hearing and disabling vertigo, most ENT surgeons routinely perform the procedure. The nondestructive nature of the surgery, low complication rate, minimal morbidity, and ability to perform the procedure as an outpatient are clearly advantages over other invasive procedures. For these reasons, and with a success rate approaching 90%, the endolymphatic sac surgery, with or without steroids, remains a valuable and reasonable option for treating the vertigo of Meniere's disease [18, 19].

The original idea for fenestration of the semicircular canal in Meniere's disease has very simple physiological basis. Most of the hydropic distension found in postmortem species is seen in the cochlea and the saccule, although occasionally the utricle and the ampulla semicircularis are involved. Making an analogy with the facial nerve decompression in the cases with Bell's pal-

sy (compressive phenomenon), we put the question whether the fenestration of the semicircular canal in the cases with endolymphatic hydrops, can induce decreasing of the pressure in the endolymphatic space in some degree? Theoretically, we thought that it's possible. *As to the reason why this effect is produced by the operation we have no theory to offer other than the supposition that it is by the distension or dilatation of the membranous canal in the decompressed perilymphatic space across the perilymphatic leak at the level of the new fenestra, and so appearing of certain decrease of the endolymphatic pressure.* This is only symptomatic, nondestructive treatment which preserves normal membranous anatomy and function. We believe that this procedure attempts to restore the function to the inner ear, rather than destroy or decrease vestibular function. And why only the posterior semicircular canal and not the other canals? There is only one reason: it is already in the operative field. One does not need to change to another body site; therefore, it saves time and reduces the chance of complications and contamination. Our future ideas in the surgery treatment of the refractory Meniere's go toward drainage of saccus endolymphaticus and fenestration of the posterior, lateral and superior semicircular canals. Whether this surgical method should be superior in correlation with others techniques remains to be shown by the postoperative results. We expect them to be successful.

CONCLUSION

Based on our results we thought that the endolymphatic sac drainage surgery and simultaneous fenestration of the posterior semicircular canal are alternative and effective methods for patients with refractory Meniere's disease. The nondestructive nature of this operative techniques is an important factor for preservation, functional and anatomical integrity of the membranous labyrinth.

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Резиме

ХИРУРШКИ ЗАФАТ НА ЕНДОЛИМФАТИЧНА КЕСА И ФЕНЕСТРАЦИЈА НА ЗАДНИОТ ПОЛУКРУЖЕН КАНАЛ ЗА МЕНИЕРОВА БОЛЕСТ

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Цел: Да се оцени ефикасноста и безбедноста на истовремената дренажа на ендолимфатичната кеса (ELSD) и фенестрацијата на задниот полукружен канал (PSCF), примарно врз функцијата на вестибулата, како нова терапевтска стратегија кај пациенти со медицински тешко излечивата Мениерова болест (MD).

Дизајн на студијата: Ретроспективна студија на следење.

Локација: Универзитетска клиника за отоларингологија.

Методи: Прегледани се дваесет и шест пациенти со MD со сериозна вртоглавица и попреченост, кои биле подложени на ELSD и PSCF истовремено во периодот од 1988 и 2007 година. Главните мерки со исход беа зачестеноста на вртоглавица, функционална попреченост според упатствата за дијагностицирање и процена на терапијата кај MD. Парезата на каналот е оценета со калориски тест. Степенот на намалена стапка на одговор на вестибуларниот систем како индикатор на вестибуларната функција беше спореден пред операцијата и по неа.

Резултати: Предоперативната аудиција веќе беше променета во сите случаи, освен кај 8 пациенти, кои немаа значителни промени во прагот на слухот. Средната вредност на нападите на вртоглавица пред операцијата беше 8,6. По 3 години од операцијата, само еден пациент (3,8 %) имал еден напад на вртоглавица. Функционалното ниво беше многу подобро, освен кај двајца пациенти со функционално ниво 2 или В во доцниот постоперативен период. Средното времетраење на калориското тестирање по 3 години постоперативно покажа дека 50 % од пациентите се приближуваат до нормалните резултати.

Заклучок: Врз основа на резултатите од истовремениот хируршки зафат на ендолимфатична кеса и фенестрација на задниот канал, тоа се ефективни методи на третман на тешко излечивата Мениерова болест. Хируршкиот зафат на ендолимфатичната кеса овозможува дренажа на ендолимфатичната течност, а фенестрацијата на задниот полукружен канал овозможува дистензија или дилатација на мембранозниот канал во декомпримириот перилимфатичен простор како резултат на перилимфатично истекување низ новиот прозорец, со што се овозможува намалување на ендолимфатичниот притисок. Двете техники истовремено го намалуваат притисокот во случај на ендолимфатични хидропси.

Клучни зборови: Мениерова болест, тешко излечива вртоглавица, хируршки зафат на ендолимфатична кеса, фенестрација на задниот полукружен канал