The Bortnick Miller apparatus: a useful alternative to impedance audiometer for assessment of eustachian tube function in chronic suppurative otitis media

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Abstract Eustachian tube function was assessed by impedance audiometer and Bortnick Miller apparatus in 60 ears with central perforation in pars tensa. Result of both the instruments were compared and presented.

Keywords Eustachian tube function · Impedance audiometer · Bortnick Miller apparatus

Introduction

Otologists generally acknowledge that the adequate eustachian tube (ET) function is a necessary prerequisite for tympanoplasty operation. Normal function of the tube is essential for the adequate middle ear ventilation. Unfortunately there is no universal agreement on what constitutes normal function and how best to measure it.

Several methods have been described to assess tubal function, but most of the methods used are complicated, time consuming and need elaborate instrumentation. The simpler methods, which are available, are non-physiological and more or less quantitative, indicating anatomical patency of the tube, which does not necessarily mean normal function.

The newer generations of impedance audiometers offer the facility to evaluate ET function in a perforated drum also. It assesses physiological function of ET rather than mere anatomical patency of the tube. It is much easier simpler and less time consuming. Graphical record can also be kept for future reference. Thus it is a boon to the otologists. But impedance audiometer is costly. In smaller centers having money constraints, the instrument called as Bortnick Miller apparatus [1], which is cheaper, can be utilized for assessing ET function in a perforated drum. It is also based on physiological principle. It is as reliable as pump manometer portion of impedance bridge. It is simple, compact, light, portable and can be prepared indigenously. The test performed with the apparatus is safe, not time consuming. It is easy to perform and interpret. This test measures the ability of ET to reduce induced negative pressure by swallowing. Considering the usefulness of both the instruments and the cost factor of impedance audiometer, the study was undertaken to assess ET function by both the instruments and compare the results. It was the objective to ascertain whether Bortnick Miller apparatus can substitute the impedance audiometer in routine day-to-day situation.

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Material and methods

Fifty patients (60 ears) having central perforation aged between 16 and 57 years were evaluated. Twenty-four patients were male and 26 patients were female. Detailed history and thorough clinical examination was done. Eustachian tube function was evaluated by impedance audiometer and Bortnick Miller apparatus in each ear.

Impedance audiometer

The impedance audiometer was programmed to artificially increase or decrease the air pressure at the middle ear and change of air pressure in middle ear was recorded as each time patient swallows. The air pressure at the middle ear end of ET is first changed either to +250 or –250 mm of water pressure (dapa). The patient is then asked to swallow repeatedly to ascertain whether the +ve or –ve pressure is being partially neutralized with each swallow. The air pressure of middle ear is monitored and recorded graphically by the impedance audiometer. Any change of pressure during swallowing is recorded as stepladder type of graph. When the subject swallows and the ET opens, sudden change in middle ear pressure occurs, immediately after this, the ET closes passively and middle ear pressure becomes steady again when the subject swallows, the middle ear pressure suddenly changes. Normally the +ve or –ve middle ear pressure should be partially neutralized with each swallow and in the three to five swallows the pressure should totally neutralized, i.e. it should read 0 mm water pressure (0 dapa). Any deviation from this is considered abnormal. If some residual pressure persists even after five swallows, the tubal function is considered to be impaired. Hypofunction can be graded as partially impaired or grossly impaired [2].

Bortnick Miller apparatus (Fig. 1)

Procedure

- Introduce tip of Foley's catheter in external auditory meatus.
- Inflate cuff to obtain airtight seal.
- Create negative pressure of 30 mm of Hg with the help of a syringe.
- Ask the patient to swallow saliva or water and note pressure equalization.
- The amount of negative pressure remaining in the tube after ten swallows is used as functional capacity of the tube and grading is done.
 1. *Normal* – when negative pressure of 30 mm Hg is brought down to zero
 2. *Mild hypofunction* – when residual negative pressure was below 10 mm Hg.

Fig. 1 Bortnick Miller apparatus

3. *Moderate hypofunction* – when remaining negative pressure was between 11 and 20 mm of Hg.
4. *Severe hypofunction* – when remaining negative pressure was between 21 and 30 mm of Hg.

Results

Sixty ears having chronic suppurative otitis media tubotympanic type were studied. Eustachian tube function was assessed by impedance audiometer and Bortnick Miller apparatus.

Evaluation by impedance audiometer

Normal ET function was present in 10% ears (6/60) while partially impaired in 63.33% (38/60) ears and grossly impaired function was seen 26.66% (16/60) ears.

Evaluation by Bortnick Miller apparatus

Normal ET function was present in 10% ears (6/60), Mild hypofunction in 16.66% (10/60) ears, moderate hypofunction in 36.66% (22/60) and severe hypofunction was present in 36.66% (22/60) ears.

Table 1 Different grades of eustachian tube (ET) function

S. No.	ET status Bortnick Miller apparatus	ET status Impedance audiometer	No. of ears Bortnick Miller apparatus	No. of ears Impedance audiometer
1.	Normal	Normal	6 (10%)	6 (10%)
2.	Mild hypofunction	Partially impaired	10 (16.66%)	38 (63.33%)
3.	Moderate hypofunction	Partially impaired	22 (36.66%)	
4	Severe hypofunction	Grossly impaired	22 (36.66%)	16 (26.66%)
Total			60	60

For all practical purposes the partially impaired category of impedance audiometer and mild and moderate hypofunction category of Bortnick Miller apparatus can be considered as the same. Thus partially impaired function by impedance and Bortnick Miller apparatus was present in 63.33% and 53.32% ears respectively. ET status by both the instruments is depicted in Table 1.

When status of middle ear mucosa and ET function was considered, in grossly impaired hypofunction of ET, middle ear mucosa was diseased (granulations or oedema) in 70% ears. In ears with partially impaired function, diseased mucosa was seen in 61%, while with normal ET function ears mucosa was normal. Association of poor tubal function with diseased mucosa in middle ear reflects similar pathological changes in mucosal lining of ET [3].

Discussion

As a response to ambient air pressure changes and to gas exchange through the mucosal lining in the middle ear cleft, the intratympanic air pressure is regulated by air, which is transported through the ET. Proper function of the ET is essential for receiving an aerated tympanic cavity after tympanoplasty surgery [4]. In present article impedance audiometer and Bortnick Miller apparatus was used to assess tubal function preoperatively. Efficacy of each instrument was compared. All the ears having normal ET function by impedance audiometer showed normal function by Bortnick Miller apparatus also. Partially impaired function by impedance audiometer was present in 63.33% ears and by Bortnick Miller apparatus in 53.32% ears.

All the ears having grossly impaired function by impedance audiometer also had severe hypofunction by Bortnick Miller apparatus, though the Bortnick Miller apparatus had more number of hypofunction cases. Thus statistically no significant difference ($p>0.482$) was found when ET function was tested by these two instruments. Singh [5] made a comparative assessment of ventilatory function in perforated drum with the help of BM apparatus and impedance bridge. He also found a highly significant correlation between these tests.

Though it was not our aim to compare ET function and graft take up, significant correlation was found between

tubal function and healing rate. Better the function more are the chances of healing. Good function predicts good outcome. Poor function demands careful examination of anterior mesotympanum during surgery. The cause of poor function could be presence of granulations, polyp, fibrosis or epithelization. Removal of the disease can result in good ET function postoperatively.

Conclusion

It is preferable to assess tubal function preoperatively. Both the impedance audiometer and the Bortnick Miller apparatus are suitable and useful instruments to assess preoperative tubal function. The added advantage of impedance audiometer is, one can also assess the ET function postoperatively after successful graft take up and can know status of tube. This is not possible with BM apparatus. Considering financial constraint for availability of impedance audiometer in small set-ups, Bortnick Miller apparatus can substitute the impedance audiometer in routine day-to-day situations to test ET function preoperatively.

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References

1. Bortnick E (1966) Simple apparatus to measure eustachian tube function. *Arch Otolaryngol* 83:38–39
2. Biswas A. Clinical audiovestibulometry for otologists and neurologists 3rd edition; Bhalani Publishing House Mumbai, pp 44–67
3. Miller GF (1965) Eustachian tube function in normal and diseased ears. *Arch Otolaryngol* 81:41–48
4. Holmquist J and Lindeman P (1987) Eustachian tube function and healing after myringoplasty. *Head Neck Surg* 96: 80–82
5. Singh M (1989) Bortnick Miller apparatus as reliable as pump manometer portion of impedance bridge for testing ventilatory function of eustachian tube in CSOM. *Indian J Otolaryngol Head Neck Surg* 41:164–165