

# Modified Bondy radical mastoidectomy: long-term personal experience

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## Abstract

The 'Bondy operation', or modified Bondy radical mastoidectomy, consists of a modification of the radical procedure by which the mastoid and epitympanum are exteriorized with preservation of the pars tensa and ossicular chain.

In the 10-year period from 1986 to 1996, 53 patients of the ENT Department of the University of Pisa underwent a modified Bondy radical mastoidectomy, performed with a personalized procedure; 45 of them had a follow up of at least five years.

After the surgical operation, the ears were free of complications in 38 cases (84.5 per cent), while in the other seven cases residual cholesteatoma (one case), tympanic retraction (four cases) or recurrent otorrhoea and phlogosis (two cases) were observed. The post-operative hearing level was unchanged or improved in 41 patients (91 per cent) (33 subjects had an unchanged gap and eight an improved gap), and only in the remaining four cases was the gap made worse. Based on our experience, the modified Bondy radical mastoidectomy is an extremely effective operation with a clear place in modern ENT surgery. When performed on carefully selected patients, it has been proven to offer good functional and anatomical results.

**Key words:** Otitis Media; Mastoid; Cholesteatoma, Middle Ear

## Introduction

At the close of the 20th century the surgical procedures used to treat chronic middle-ear disease all involved either simple or radical mastoidectomy, with no attempt to preserve the pre-operative hearing level. In 1910, Bondy set forth the technique of, and indications for a 'modified radical mastoidectomy' in cases of chronic otitis media with epitympanic cholesteatoma in the presence of a defective pars flaccida, but an intact pars tensa. The purpose of the Bondy operation was to obtain a 'safe ear', while at the same time preserving the pre-operative hearing level.<sup>1</sup> Although Bondy had very clearly delineated the indications for, and surgical technique, of this procedure, it was not generally accepted until the 1940s, when its performance became popularized by a few otological surgeons (most importantly, Baron, Day and Shambaugh). Thus, the number of patients who were subjected to the radical alternatives began to diminish.<sup>2–4</sup>

Bondy's original procedure called for exteriorizing the cavities of the mastoid and epitympanum, while preserving the integrity of the pars tensa and ossicular chain. Removal of the posterior canal wall and lateral attic wall enabled the attic and antral

cholesteatoma to be exteriorized while leaving the matrix intact and creating a modified permanently accessible radical cavity that discharged through the external meatus.<sup>5</sup>

However, codification of the tympanoplasties by Wullstein and Zöllner<sup>6,7</sup> in the 1950s and the introduction of intact canal wall tympanoplasty by Jansen<sup>8</sup> in 1968 limited the indications for the radical mastoidectomies. Furthermore, some of the drawbacks affecting the original Bondy operation led many surgeons to give up this type of procedure altogether. Thus, between the 1950s and 1980s the Bondy operation fell into near obscurity, and only a few studies in the current literature contain any mention of this technique, despite the fact that it actually offers many advantages over alternative procedures.

The main disadvantages of the original Bondy operation stemmed from the incomplete removal of the perilabyrinthine air cells and preservation of the cholesteatoma matrix, which can continue to erode the bone and lead to formation of granulation tissue and otorrhoea.<sup>5,9</sup> Furthermore, incomplete lowering of the facial ridge can bring about depressions in the mastoid cavity, where, due to the lack of ventilation, crusts and epidermal debris can accumulate, with subsequent otorrhoea.

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During the 1990s the Bondy operation was re-evaluated by Sanna's group and Pappas, who introduced some important modifications to the surgical techniques used in Bondy's original procedure.<sup>10,11</sup> The modified radical mastoidectomy proposed by Sanna's group calls for executing a wide cortical mastoidectomy, carefully skeletonizing the plates of the middle fossa dura and sigmoid sinus, and making a wide opening in the mastoid cavities and sino-dural angle; the anterior canal wall is also widened. In this way, a smooth round cavity is created. The tympanic cavity is also examined by performing a large posterior tympanotomy. Subsequently, the facial ridge is extensively lowered in order to obtain a round cavity instead of a kidney-shaped one.<sup>9,10,12</sup> For reconstruction, these authors utilized some pieces of cartilage that can be placed between the medial attic wall and the body of the incus (in cases of a very wide epitympanic space), thus preventing epitympanic retraction.<sup>9,12</sup> Subsequently, the cartilage fragments are covered with a temporalis fascia graft placed medially to the ossicular chain in the epitympanic space and medially to the pars tensa of the tympanic membrane.<sup>9</sup> At this point, the skin flaps are replaced, and a wide meatoplasty is performed in all cases.<sup>9</sup>

Dennis Pappas<sup>11</sup> has also proposed a modified radical mastoidectomy in which partial obliteration of the attic space is performed in order to avoid post-operative retractions, although this author utilizes bone pâté, particularly in the anterior epitympanic space, superior to the semicanal of the tensor tympani muscle and medial to the head of the malleus and body of the incus. Subsequently, the temporalis fascia is spread under the tympanic membrane to cover the attic and mastoid.<sup>11</sup>

The aim of the current retrospective study is to present the long-term anatomical and functional results obtained in a group of patients who underwent a modified Bondy radical mastoidectomy at the ENT Department of Pisa University. The surgical procedure was performed in the same way by all the surgeons and was characterized by some personal technical features.

## Materials and methods

Between September 1986 and July 1996, 53 patients (37 males and 16 females; age range: from 23 to 72 years; average age: 43 years) underwent a modified Bondy radical mastoidectomy at the ENT Department of the University of Pisa. The criteria that we followed in the selection of the patients were: mastoid and epitympanic cholesteatoma without involvement of the medial epitympanic space; integrity of the tympanic cavity and tympanic pars tensa; intact ossicular chain; good pre-operative conductive hearing level. The surgical technique adopted presents several differences with respect to the previously described procedures. Of the 53 patients treated with this modified version of Bondy's radical mastoidectomy, the authors succeeded in maintaining follow-up for at least five years in only 45 subjects, who have been analyzed

retrospectively for this study (follow-up: from five to 14 years, average: 8.8 years).

All patients were suffering from epitympanic cholesteatoma, with intact pars tensa and intact ossicular chain, so that they were all managed by a 'Bondy operation' without ossiculoplasty. Two subjects presented a fistula of the lateral semicircular canal. In 21 cases (40 per cent of all patients) the otological disease was bilateral. In all the cases in question, the decision to perform a modified Bondy radical mastoidectomy was made during surgery – the choice depended upon the anatomic-pathological features of the individual case.

All patients underwent pre- and post-operative audiological evaluation by pure-tone audiometry (air and bone conduction). A comparison study was conducted between the pre- and post-operative air-bone gap, analyzing the mean threshold at the frequencies of 0.5, 1, 2, 3 kHz (four-tone pure-tone average: FPA).<sup>13</sup> In comparing the pre- and post-operative air-bone gaps (0.5, 1, 2, 3 kHz), the post-operative gap was considered to be unchanged if the FPA was  $\pm 10$  dBs, improved if the FPA was reduced by more than 10 dBs, and worsened if the FPA increased by more than 10 dBs. Finally, cochlear damage was suspected when a deterioration of  $\geq 15$  dBs was detected in at least two frequencies of the bone conduction tests.

## Surgical procedure

The entire operation is carried out using the operating microscope. With the patient under general anaesthesia and after retroauricular and endaural infiltrations (two per cent lidocaine and 1:100 000 epinephrine), vertical and horizontal incisions are performed in the canal skin, 3 mm from the annulus at respectively six and 12 o'clock. The meatal skin is elevated from the bony wall, with preparation of the vascular strip, as in a closed technique. With a classical retroauricular approach, a large temporalis fascia is taken for later grafting, then the mastoidectomy is performed without skeletonizing the middle fossa dura plate or the sigmoid sinus plate. Subsequently, the anterior and lateral epitympanic spaces are exposed without altering the ossicular chain. At this point, the postero-superior canal wall and the lateral attic wall are removed, and the facial ridge is lowered in its inferior part up to the annulus, while the area of the posterior and inferior tympanotomy is not generally extended. Then, the residual air cells are removed from the region of the zygomatic root and tegmen tympani. Exeresis of the cholesteatoma (if present) from the perilyabyrinthine air cells and ossicular chain (malleus head – incus body) is performed, and the anterior and medial epitympanic spaces and sinus tympani are carefully examined. In the present procedure, the anterior canal wall is not widened.

At this time, reconstruction can be performed. Firstly, any posterior or subfacial depressions are filled with bone pâté, collected during drilling of the mastoid bone and mixed with fibrin glue (Tissucol®).

Then a large temporalis or epicranial fascia graft is spread under the tympanic membrane and above the malleus head and incus body. In six of the cases complete exeresis of the diseased tissue was uncertain, and so the fascia graft was placed in the medial epitympanum, under the ossicles. A large fascia graft was also performed in the mastoid cavity above the bone pâté.

Then meatoplasty is carried out (Stacke's technique)<sup>14</sup> via a vertical incision between the concha and the posterior canal wall and a horizontal incision along the postero-superior angle of the canal. The skin flaps are replaced (the postero-inferior one first, then the superior one) and sutured. Finally, the cavity is packed with gelfoam and Merocel.

### Functional and anatomical results

With regard to the anatomical features, the ears were free from complications, with a dry, smooth round cavity, in 38 cases (84.5 per cent) (Table I). In the other seven cases some anatomical problems were encountered during follow up: in one patient residual cholesteatoma of the anterior epitympanic spaces was detected one year after the operation, and the subject had to undergo surgical revision; in two cases posterior tympanic retraction occurred; two patients showed retraction in the attic with epidermal debris, however, without otorrhoea or changes in hearing threshold (these subjects were repeatedly aspirated and cleaned at intervals through an office procedure); in the remaining two patients the presence of recurrent otorrhoea, phlogosis, epidermal debris or granulations in the mastoid cavities suggested the advisability of cleaning and removing the pathologic tissues under local anaesthesia via an office procedure. Three subjects exhibited insufficient meatoplasty, and although they did not present with otorrhoea, thorough examination of the mastoid cavity was impossible.

With regard to the functional features, 41 patients (91 per cent) exhibited unchanged or improved hearing levels (73 per cent of cases with unchanged gap and 18 per cent with improved gap), while in only four cases (nine per cent) was a worsening of the air-bone gap observed (>10 dBs, Table I). A high-frequency sensorineural hearing loss, probably caused by acoustic trauma during drilling, was detected in four patients (nine per cent). After five years (i.e., minimum follow-up) only three patients

presented significant worsening of the air-bone gap (>10 dBs), and marked tympanic retraction was observed in two of them.

### Discussion

Modified Bondy radical mastoidectomy is an extremely effective operation when performed on carefully selected patients. Its main indications are mastoid and epitympanic cholesteatoma with good pre-operative conductive hearing level, integrity of the tympanic cavity and tympanic pars tensa, and intact ossicular chain or only partial erosion of the ossicles (incus body and short process, malleus head). If the cholesteatoma is located in the medial attic, the Bondy operation is not recommended because the malleus head and incus would have to be removed.<sup>5,9,11</sup> Despite pre-operative audiological and otomicroscopic workups, all these anatomical features can be evaluated only during the surgical procedure. During the present study experiences, a Bondy radical mastoidectomy was performed in only 6.4 per cent of all the surgical operations for cholesteatoma.

Although the main indications are those stated above, there are other, less critical factors that must be taken into account when making the choice between open or closed tympanoplasty: the degree of mastoid pneumatization (the operative cavity is smaller and so after an open technique will produce fewer problems if the mastoid process is sclerotic and/or diploic, as usually happens in adults with chronic otitis media with cholesteatoma); the age of the patient (although the Bondy operation can be performed in childhood, the possibility of adopting a closed technique must be carefully considered); the advisability or necessity of performing a single-stage surgical procedure (sometimes a second look is impractical because the patient either lives far away and is unable to return, or is uncooperative); the presence or absence of pathology in the contralateral ear (if the otological disease is bilateral, there is a greater risk of a non-functioning eustachian tube, which can cause recurrence of the disease after a closed technique).<sup>9,10</sup>

From both the authors' personal experience and a review of the results reported in the literature, a modified Bondy radical mastoidectomy, rather than a closed or open tympanoplasty, should always be performed when the aforementioned main indications are present. Indeed, in cases of epitympanic and mastoid cholesteatoma, a closed technique

TABLE I  
ANATOMICAL AND FUNCTIONAL RESULTS (TOTAL NUMBER OF CASES = 45)

Anatomical results		Functional results	
38 cases (84.5%)	Dry cavity free of complications	33 cases (73%)	Unchanged air-bone gap ( $\pm 10$ dBs)
1 case (2.3%)	Residual cholesteatoma of the anterior epitympanic spaces	8 cases (18%)	Improved air-bone gap (>10 dBs)
2 cases (4.4%)	Posterior tympanic retraction	4 cases (9%)	Worsened air-bone gap (>10 dBs)
2 cases (4.4%)	Attic retraction with epidermal debris		
2 cases (4.4%)	Recurrent otorrhoea, phlogosis, epidermal debris or granulations in the mastoid cavity	4 out of 45 cases (9%)	High-frequency (3, 4 kHz) moderate sensorineural hearing loss

produces a high incidence of recurrent or residual disease because patients with this type of cholesteatoma often suffer from bilateral otological pathology, that signifies a non-functioning eustachian tube and a consequently higher risk of recurrence after closed tympanoplasty than after a Bondy operation.<sup>10,15,16</sup> Furthermore, closed tympanoplasty requires two surgical stages and a higher number of surgical revisions. Lastly, its percentages of preservation or improvement of the pre-operative hearing are about 60 per cent, a lower value than those obtained in the authors' experience with the Bondy operation, and this finding is corroborated by other otology surgeons.<sup>9,10,17</sup>

- **10 years experience of modified Bondy radical mastoidectomy**
- **53 cases; 84.5 per cent free of complications**
- **91 per cent had unchanged or improved hearing**
- **Effective operation giving good functional and anatomical results**

In the patients in this study treated via the modified Bondy radical mastoidectomy, post-operative healing was rapid and the ear was stable during follow-up. In fact, since the great majority of cholesteatomas occur in sclerotic and/or diploic mastoid bones, and the paramastoid cavities are partially filled with bone pâté, the resulting operative cavity is small. Thus, the post-operative hearing level was usually good, and the air-bone gap did not seem to undergo significant deterioration during follow-up. Residual cholesteatoma also occurred in a low percentage of cases, and recurrent cholesteatoma was wholly absent. Finally, performing only one surgical procedure offers great practical advantages over closed techniques.<sup>9,11</sup>

The surgical technique adopted to perform the modified Bondy radical mastoidectomy in the patients under study is distinguished by a number of features that seem to optimize the anatomical and functional results. The middle and posterior fossa dura plate or the sigmoid sinus plate were not skeletonized, but the mastoidectomy was performed by simply removing the inflammatory tissue (in most cases the mastoid cavity is small and sclerotic, a feature that facilitates the surgical operation). Furthermore, the facial ridge is extensively lowered up to the annulus, without however performing a posterior or inferior tympanotomy. If the cholesteatoma matrix is not too strongly attached to the ossicles, the authors always try to remove it entirely. Subsequently, each depression below the facial wall and in the mastoid cavity is filled with bone pâté and fibrin glue (Tissucol®), which are then covered with the large fascia. The same procedure is followed to reduce the mastoid cavities, because a narrower mastoid cavity improves ventilation (no significant long-term resorption of bone pâté was encountered

in these patients). The antero-superior and infero-anterior osseous walls of the external canal remain intact, and this eases and hastens healing.

With regard to the functional results, it is preferable not to place cartilage fragments or bone pâté into the medial attic and to avoid spreading the fascia graft under the ossicular chain because both practices may result in problems related to the risk of excessive mobility and/or subsequent fixedness of the chain. In conclusion, the result is a small, smooth cavity that allows a limited and aesthetically satisfactory meatoplasty to be performed.

The disadvantages of the Bondy operation to patients are very limited and essentially stem from the problems caused by them getting water in the surgical cavity, especially during water sports. However, most of the patients treated via the modified technique presented herein are able to bathe, swim and perform other activities in water without problems. Lastly, the risk of sensorineural hearing loss from the acoustic trauma during drilling must always be taken into account, although this risk is low and similar to that involved in closed tympanoplasty.<sup>9,12</sup>

### Conclusions

After the reevaluation made of its effectiveness during the 1990s, the modified radical mastoidectomy currently appears to be a very interesting, up-to-date surgical operation, yielding functional and anatomical results superior to those of closed tympanoplasty, if performed in select cases.

The strict criteria that must be observed in selecting candidates for this technique (mastoid and epitympanic cholesteatoma not situated in the medial attic, intact tympanic cavity and pars tensa, integrity of the ossicular chain) can sometimes be broadened to include, for instance, when limited erosion is present of the body or short process of the incus or the head of the malleus, or when a small tympanic perforation is observed which can be repaired while preserving the ossicular chain. Furthermore, the Bondy operation can also be performed in some cases of spontaneous myringo-stapedioplasty with a good hearing level,<sup>5</sup> if cholesteatoma is absent in the retrotympanum.

The advantages of the Bondy operation over closed techniques consist of lower incidence of residual cholesteatoma, the absence of recurrent cholesteatoma, the ability to perform the procedure in one stage, fewer surgical revisions and better functional results. In conclusion, a modified radical mastoidectomy should always be considered in cases of epitympanic cholesteatoma with normal or near-normal hearing, even if the precise choice of surgical technique can only be made intra-operatively.

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