

Review Article

Subtotal petrosectomy: a comprehensive review

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ABSTRACT

Subtotal petrosectomy (STP) is usually recommended for extensive pathology confined primarily to middle ear and mastoid, particularly for treatment of a large post-surgical cavity. It has been associated with middle ear procedure with blind sac closure of the external auditory canal. The Eustachian tube is obliterated in STP. The cavity is obliterated with autologous abdominal fat soaked in antibiotic ear drops. The extended skull base procedures are also sometimes referred to as STP. Because STP offers the potential for a permanent recovery with radical temporal bone clearing, it makes it possible to treat a wide range of diseases. Additionally, STP has a very low risk of complications when used in conjunction with other surgical procedures. STP has gained popularity during the last few decades, and its indications have expanded as well. When treating a complex case of tympanomastoid cholesteatoma, STP is a very safe and effective surgical treatment since it offers radical clearance, which may result in a permanent cure. STP can also be safely combined with hearing implantation procedure. During cochlear implantation, STP has been demonstrated to be useful for making a sterile, closed-off environment in the middle ear and for providing great visualization.

Keywords: Subtotal petrosectomy, Cholesteatoma, Blind sac closure, Cochlear implantation

INTRODUCTION

Subtotal petrosectomy (STP) is frequently used to treat temporal bone disorders and persistent or potentially fatal infections.¹ It is mostly used in patients with posttraumatic or postoperative cerebrospinal fluid leaking and in cases of severe cholesteatoma, such as petrous cholesteatoma.² In cases when an open cavity surgery has already been performed, the other indication is cochlear implantation or active middle ear device implantation.³ STP, which involves closing the external auditory canal and obliterating the middle ear and mastoid, is a successful treatment for recurrent and chronic mastoid and middle ear diseases. It leaves behind a large surgical cavity that exposes important structures like the dura, internal carotid artery, inner ear fluids, or cerebrospinal fluid, and there is no realistic chance of reconstructing conductive apparatus. This procedure involves eradicating the entire middle ear cavity and its associated

pathologies, obliterating the resulting space with adipose tissue, and closing external auditory canal as a blind sac. STP is classified as an M3a otic capsule preserving surgery under the SAMEO-ATO and it prevents future infection by eradicating all mucosa and sealing the eustachian tube.⁴ STP has a high cure rate and eliminates the need for routine postoperative care, although a significant trade-off is that postoperative conductive hearing loss is inevitable. Interest in STP has grown over the last few decades, and there have also been more signs of STP. Additionally, STP is used in conjunction with hearing device implantation.⁵ Devices like vibrant sound bridges and cochlear implants are frequently installed in a single step with positive results.⁶

METHODS OF LITERATURE SEARCH

Research articles on STP were sought after. This started by looking through online databases including Google

Scholar, Scopus, PubMed, and Medline, which covered the research that has been published up to this point. This scoping review assessed the STP and followed the preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) guidelines. The manuscript includes the specific search terms and Boolean operators used e.g. "STP". Once the data have been extracted from all articles, numerical and thematic analysis were conducted. All search results were reviewed based on inclusion and exclusion criteria. The data included all age groups and both genders with STP. Articles were initially screened by their titles to determine eligibility, followed by a thorough review of each abstract to ensure they met the inclusion criteria. The study include in this review are restricted to English language. The citations were employed manually

to locate further research articles after the search strategy turned up published article abstracts. Articles were excluded as per the criteria such as non-peer reviewed articles, non-original research, reviews, case reports, letters, editorials, insufficient information on STP. The evaluation assessed whether observational studies, comparative studies, case series, case reports, and randomized controlled trials were appropriate. Thirty three of the 71 publications (25 case reports, 20 case series, and 26 original studies) that were discovered in different databases were included in this PRISMA Flow diagram for study selection (Figure 1). The synthesis of findings was conducted by use of quantitative and qualitative methods. This review article discusses the history, indications, surgical techniques, complications, and quality of life related to STP.

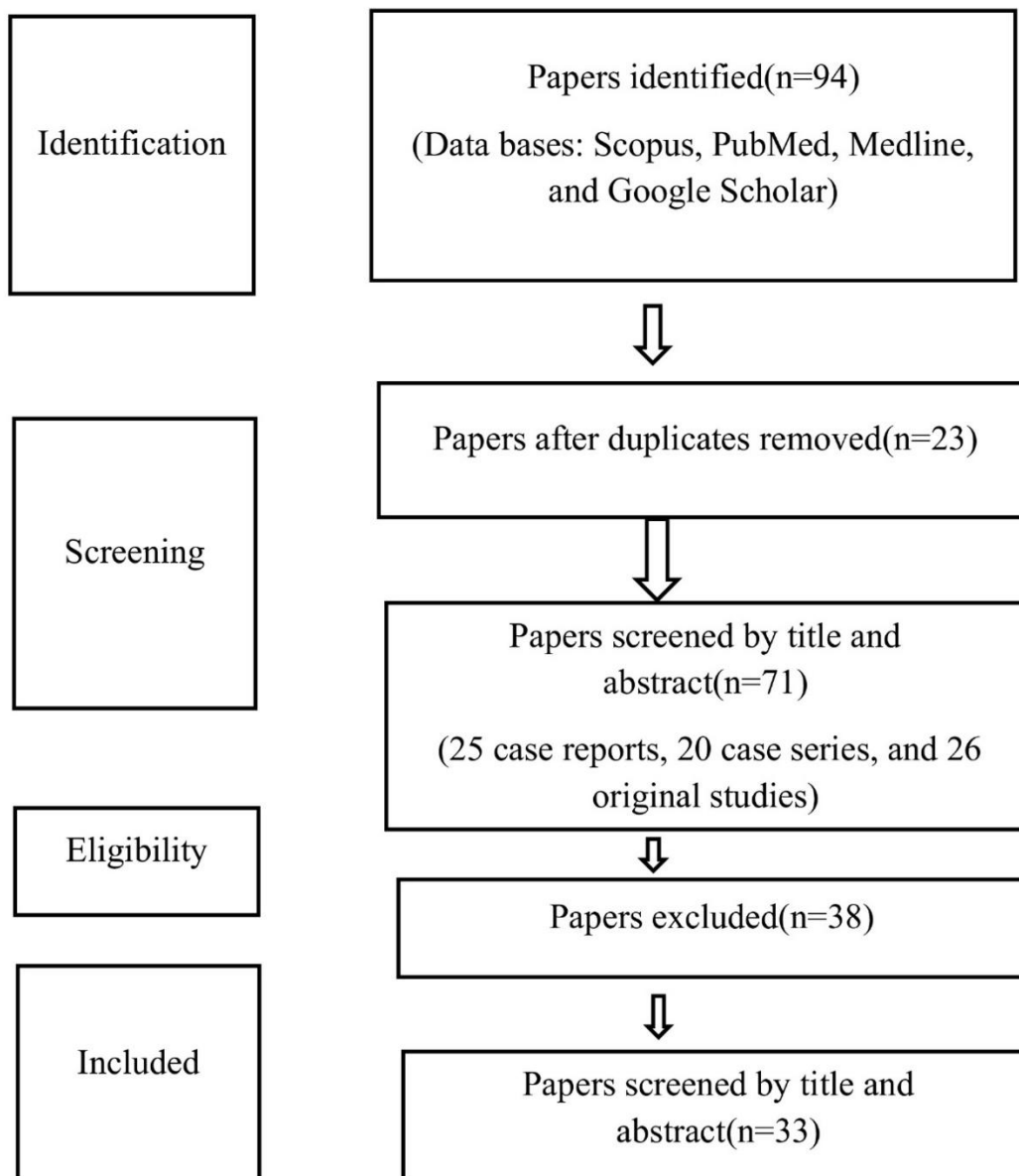


Figure 1: Methods of literature search.

HISTORY

Rambo et al are attributed with the first mention of STP. They used a temporalis muscle pedicled flap to obliterate the cavity without obliterating the external auditory canal or eustachian tube.⁷ While the terms "middle ear obliteration" and "total obliteration of the mastoid, middle ear (cleft), and external auditory canal" have previously been used, Coker et al used the phrase "subtotal petrosectomy" in 1986.⁸ But Ugo Fisch distinguished between STP and other lateral skull base surgical techniques in 1988. According to Ugo Fisch, it is the complete extenteration of the temporal bone's pneumatic cell fibers, which include the retrosigmoid, retrofacial, antral, retrolabyrinthine, supralabyrinthine, infralabyrinthine, peritubal, and pericarotid cells.⁹ Despite the fact that STP is a common surgical technique in Western nations, Prasad et al reported a significant series of 460 instances in 2017.¹⁰ Over the past 20 years, otologists have shown a great deal of interest in STP, which has contributed to an increase in its indications.

INDICATIONS

STP is indicated for extensive disease confined primarily to the middle ear and mastoid, specifically for the treatment of a large, unstable post-surgical cavity.¹¹ Because of its invasiveness, STP is frequently seen as a last choice for cholesteatoma and persistent otitis media. In some cases, a more invasive surgical technique involving total extenteration of all air cells, obliteration of the middle ear and mastoid, and closure of the external auditory canal is required when even a canal wall down mastoidectomy fails to completely eradicate the disease.¹¹ Due to growing evidence that the recurrence incidence of cholesteatoma in operated ears with STP is extremely low, this technique is currently gaining popularity.¹² STP is frequently used for chronic otitis media with cholesteatoma when there are several signs of recurrence and no practical possibility of reconstructing the middle ear's conductive system, or when the procedure is carried out on a deaf ear. It is appropriate when the carotid artery, dura, or sigmoid sinus are exposed due to a large mastoid cavity left by the cholesteatoma. If the removal of a cholesteatoma creates fistulas that cause inner ear or cerebrospinal fluid leaks, it is safe to obliterate the middle ear.¹³ When this surgical procedure is carried out appropriately, the recurrence rate is extremely low, but it is still not zero.¹³ STP is sometimes used to describe even more complex skull base surgical techniques, such as transotic, transcochlear, and infratemporal approaches; temporal bone resections; various skull base procedures for tumors of the middle and posterior fossa; and surgery for parotid gland illness.¹⁴

STP AND COCHLEAR IMPLANTATION

Treatment of recurrent chronic otitis media associated with unserviceable hearing loss needs a specialized approach with regard to disease eradication and hearing

rehabilitation.¹⁵ STP can enable cochlear implantation in ears with diseases like persistent middle ear infections that were previously thought to be contraindicated. STP now plays a larger part in getting a diseased middle ear ready for cochlear implantation. The sterile field is ideal for cochlear implantation since STP involves total extenteration of all temporal bone air cells, obliteration of the mastoid cavity, and closure of the external auditory canal and eustachian tube.¹⁶ Cerebrospinal fluid leaks, temporal bone or skull base malignancies, significant middle ear illness, and possible infectious aftereffects from temporal bone fractures are all treated with STP.¹⁷ In addition to any cochlear or sensorineural hearing loss, STP results in maximum conductive hearing loss. If the cochlear reserve is appropriate, additional surgery such as cochlear implantation can overcome the conductive hearing loss. STP is useful for a broad surgical exposure that supports careful cholesteatoma excision. If there is cholesteatoma or inflammation, a multistage surgery may be necessary.

STP AND MIDDLE EAR PARANGLIOMAS

STP is widely used for middle ear tumor such as paragangliomas, which are uncommon. The benign and locally aggressive tumors known as temporal bone paragangliomas originate from several locations inside the temporal bone. Tympanomastoid paragangliomas, also known as glomus tympanicum, and tympano-jugular paragangliomas, also known as glomus jugulare, are two types of paragangliomas that either originate from the hypotympanum and invade the bulbus jugularis secondarily, or they arise from the paraganglia in the adventitia of the bulbus jugularis dome.¹⁸ STP is the most effective treatment for patients with mastoid tumors since advanced lesions frequently cause hearing impairment.¹⁹ According to one study, hearing loss both before and after surgery is negligible and acceptable even with STP.²⁰

STP AND MALIGNANCIES OF EAR AND PAROTID GLAND

Larger lesions, such as malignant tumors of the skin of the external auditory canal, temporal bone, or parotid gland invading the ear, may be radically removed with STP. A lateral temporal bone resection, commonly known as a partial petrosectomy, is frequently performed in malignant tumors as the least amount of resection required to completely remove the illness. According to Fisch et al a more aggressive surgical technique that may be customized for the surgical treatment of parotid gland cancers with skull base invasion is also known as STP.²¹

SURGICAL TECHNIQUE

A wide S-shaped postauricular skin incision is made that give access from the temporalis muscle to jugular foramen.²² A neural integrity monitor is used to keep an eye on the face nerve during surgery. The temporalis muscle is separated from the skin and subcutaneous

tissue. The Musculo-periosteal flap is shaped with a posteriorly based pedicle and elevated in a T fashion. The skin of the external auditory canal is exposed and separated from the bone in the superior, posterior, and inferior quadrants. At the bony-cartilaginous junction, a circumferential incision is made through the canal skin. The skin is then carefully separated from the cartilage all around and is everted outward. The resulting distal skin cuff is meticulously dissected from the cartilage and everted to make the blind sac.²² The closure is performed in two layers: first, the skin edges are securely approximated using 4-0 absorbable sutures, and second, the underlying cartilage is sutured to reinforce the seal. Medially, the tympanomeatal flap is elevated to the annulus and finally resected in its entirety, ensuring that no squamous epithelium remains. A mastoidectomy is performed and sigmoid sinus, middle fossa dura, and sigmoid angle is exposed. The canal wall down mastoidectomy is done with complete exenteration of all air cell tracts which are involved in the disease or which are needed to remove as per the indication of surgery. All visible mastoid air cell tracts are removed during a canal wall down mastoidectomy, but the dural plates, facial nerve, and otic capsule are left intact.²³

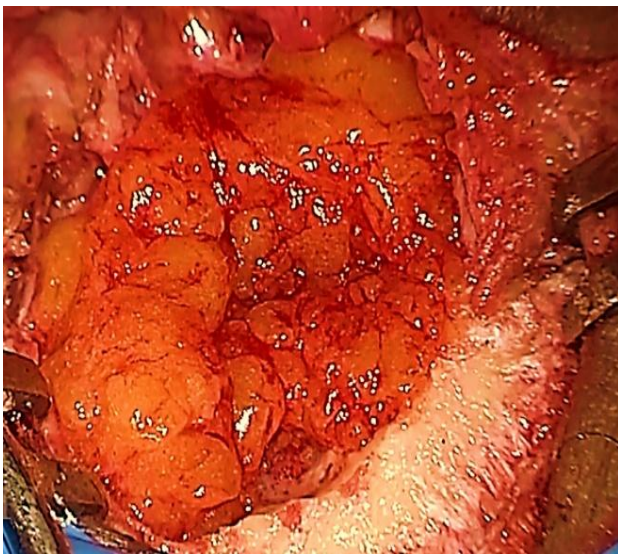


Figure 2: Operative cavity obliterated with autologous abdominal fat.

A mucocele may develop if all mastoid air cells are drilled and no mucosa is left behind. The jugular bulb is connected to the sigmoid sinus. The semicircular canals are located and preserved when the mastoid is drilled using a canal wall down technique until the petrous bone's apex is reached. The stylomastoid foramen is where the facial nerve is located after being recognized at the second genu. To avoid an opening to middle ear, it is crucial to carefully close the eustachian tube at the middle ear's anterior wall.²³ The mucosal lining of the eustachian tube entrance orifice is mobilized and folded back into the eustachian tube. The mucosa is cauterized by bipolar coagulation and then the tympanic orifice of

the Eustachian tube is permanently occluded by a plug of periosteum, muscle, or cartilage, which can be secured with bone wax or fibrin glue.²⁴ The operative cavity is obliterated with autologous abdominal fat soaked in antibiotic ear drops (Figure 2). While the extent of cellular exenteration may be restricted in the case of STP for cochlear implant following a radical cavity, considerable cell drilling is required in the event of STP for severe cholesteatoma.

COMPLICATIONS

Postoperative complications following STP include wound breakdown at the postauricular or blind sac closure site, infection, and fat graft necrosis, are significant challenges.²³ Nerve injury, hearing loss, facial weakness, and balance problems are important complications occur following STP. Patients undergoing STP may experience recurring disease in the petrosectomy cavity or late sequelae. Entrapped skin or matrix and possible development of cholesteatoma are important risks that should be addressed to the patients on the long-term follow up. The post-operative imaging with magnetic resonance imaging (MRI) provides artifacts and will make follow-up on the primary pathology more difficult. The follow up can be done with high resolution computed tomography (HRCT) to check entrapped cholesteatoma.²⁵

The radiological interface made by the fat in the tympanomastoid cavity increases the diagnosis of HRCT for residual and entrapped cholesteatoma.²⁶ The postoperative conductive hearing loss is an unavoidable condition of STP, which need auditory rehabilitation such as a cartilage conductive hearing aid, a bone anchored hearing aid, or an active middle ear implant can be considered.²⁷ The wound dehiscence with infection of fat after STP often refractory to conservative treatment and typically need revision surgery. In case of wound breakdown with exposed or necrotic fat, the standard approach involves surgical debridement of the infected tissue. A vascularized flap can then be used to re-obliterate the cavity. In addition to systemic antibiotic treatment based on microbiological results, the temporary implantation of antibiotic-loaded beads may be taken into consideration if there is a substantial infection. To ensure a tension-free closure during revision procedures, the anterior portion of the temporalis muscle may need to be mobilized. Severe conductive hearing loss is caused by middle ear obliteration.²⁸ Because of this, STP is typically only used for patients who have poor hearing function or in situations when there is no other option due to the severity of the issue that poses a risk to the patient's safety, such as a significant tegmen defect that is challenging to fix using conventional methods.²⁹

QUALITY OF LIFE

STP often improves quality of life among patients with severe chronic ear disease by eliminating infection

leading to high satisfaction.³⁰ However, it may result in significant hearing loss and potential aesthetic/functional changes, making post-surgery aural rehabilitation crucial for maximizing quality of life, especially when combined with cochlear implantation.³⁰ Patients experience improved symptom control, less activity restriction, and better cosmetic outcomes, yet STP sacrifices hearing, making trade-offs in daily life. STP is a treatment option for management of extensive primary cholesteatoma where hearing reconstruction is not feasible, particularly in the elderly population.³¹ STP is an effective surgical technique for chronic or recurrent middle ear and/or mastoid disease, especially for ears with no functional hearing.³² The risk of residual disease can lead to recurrence, so careful surgical indication is essential to avoid potential over-indication. The meticulous surgical technique and rigorous postoperative imaging surveillance are important part to ensure long term disease control.³³

CONCLUSION

STP is an important surgical procedure for diseases of the middle ear and lateral skull base. STP is indicated for management of extensive primary cholesteatoma where hearing reconstruction is not possible, particularly in the elderly population. STP helps disease clearance by providing unmatched exposure in difficult otological conditions and also helps to isolate middle ear cleft from external environment thereby eliminating diseases of the mastoid cavity. As more otoneurologists and skull base surgeons gain expertise in the subtleties of this procedure, the indications for STP are growing. In skilled hands, STP is a safe procedure with minimal complications.

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