

## Original Research Article

# Surgical outcome of canal wall down mastoidectomy with or without cavity obliteration

Mohammad Shamsul Alam<sup>1\*</sup>, M. Mazharul Shaheen<sup>2</sup>, M. Sahbub Alam<sup>3</sup>,  
Mohammad Mostafizur Rahman<sup>4</sup>, Tanni Kundu Tanu<sup>5</sup>

<sup>1</sup>Department of ENT and Head-Neck Surgery, 250 Bed General Hospital, Bhola, Bangladesh

<sup>2</sup>Department of ENT and Head-Neck Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh

<sup>3</sup>Department of ENT, National Institute of ENT (NIENT), Dhaka, Bangladesh

<sup>4</sup>Department of ENT, Sir Salimullah Medical College Mitford Hospital, Dhaka, Bangladesh

<sup>5</sup>Department of Public Health, North South University, Dhaka, Bangladesh

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### \*Correspondence:

Dr. Mohammad Shamsul Alam,

E-mail: drshamsul08@gmail.com

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## ABSTRACT

**Background:** Canal wall down (CWD) mastoidectomy is commonly used to treat chronic otitis media with cholesteatoma. Cavity obliteration may improve postoperative outcomes by reducing cavity-related complications. Aim of the study was to compare surgical outcomes of CWD mastoidectomy with and without cavity obliteration.

**Methods:** This prospective longitudinal observational study was conducted at Sir Salimullah Medical College Mitford Hospital, Dhaka, from July 2023 to June 2024. Eighty patients with active squamous chronic otitis media undergoing CWD mastoidectomy were enrolled. Group I had no obliteration; group II underwent obliteration using vascularized periosteum-temporofascial swing, bone dust, and cartilage. Outcomes included cavity discharge, giddiness, epithelialisation, wax formation, hearing, meatal stenosis, residual cholesteatoma, and facial nerve palsy.

**Results:** Mean age was comparable ( $27.92 \pm 8.23$  versus  $27.28 \pm 8.19$  years;  $p=0.724$ ), with male predominance in both groups. At three months, dry cavity was achieved in 95.0% of group II versus 72.5% of group I ( $p=0.015$ ). Persistent giddiness was lower in group II (2.5%) than group I (20.0%). Complete epithelialisation occurred in 90.0% of group II versus 60.0% of group I ( $p=0.004$ ). Wax formation was lower in group II (5.0%) than group I (20.0%). Postoperative hearing was significantly better in group II ( $45.82 \pm 5.38$  dB versus  $48.22 \pm 4.07$  dB;  $p=0.027$ ), with greater hearing gain ( $10.22 \pm 5.42$  dB versus  $7.95 \pm 3.68$  dB;  $p=0.031$ ). Meatal stenosis and residual cholesteatoma were less frequent in group II, and no facial nerve palsy occurred.

**Conclusions:** Cavity obliteration in CWD mastoidectomy provides better postoperative outcomes, including improved cavity healing, reduced complications, and superior hearing improvement.

**Keywords:** Cholesteatoma, Mastoidectomy, Obliteration

## INTRODUCTION

Chronic otitis media (COM) is a permanent abnormality of the pars tensa or flaccida, most likely a result of earlier acute otitis media, negative middle ear pressure or otitis media with effusion.<sup>1</sup> Traditionally it is a long standing inflammation of the middle ear, and the mastoid and in

most cases it is seen in association with perforation of tympanic membrane, as well as otorrhoea.<sup>2</sup> The global burden of illness from COM estimated to involve about 65 to 330 million individuals with draining ears, 60% of them suffers from significant hearing impairment. Ninety (90) percent of burden is borne by developing countries, in southeast Asia, the western region of Africa. COM can

occur with or without cholesteatoma.<sup>3</sup> Muller in 1838 first used the term 'cholesteatoma' describing what he thought it is a neoplastic lesion with keratin flakes appearing to look like cholesterol crystals. Despite its 'oma' suffix, cholesteatoma is not a true neoplasm, even taking account of the propensity for the keratin epithelium to accumulate and invade the middle ear and mastoid and to erode the temporal bone. A recent consensus definition is: 'cholesteatoma is a mass formed by keratinizing squamous epithelium in the middle ear and/or mastoid, subepithelial connective tissue and by the progressive accumulation of keratin debris with/without surrounding inflammatory reaction'.<sup>1</sup> As the cholesteatoma grows, it can damage the middle ear ossicles and mastoid bone leading to hearing problems. Cholesteatoma may erode facial canal and can cause facial nerve palsy. Cholesteatoma can spread to the inner ear or brain and cause meningitis or brain abscesses. The primary treatment for a cholesteatoma is surgery to remove the growth and prevent further damage to the ear. In cholesteatoma surgery, the two major and traditional surgical approaches which are commonly used are more or less antagonistic in their concept. The functional approach is called canal wall up (CWU), which keeps the posterior wall of the outer ear canal intact during surgery.<sup>4</sup> The greatest problem with intact canal wall (ICW) techniques are the recurrence rates, reported as high as 40 to 60% in children and 20% in adults.<sup>5</sup> The radical approach is called canal wall down (CWD) surgery, usually ending up in an open cavity. When applying this technique, the posterior wall of the ear canal is removed during surgery, and a common cavity is created from the outer ear canal and the mastoid bowl.<sup>6</sup> This, however, leads to the development of a mastoid cavity, which is neither natural nor satisfactory from an anatomical and physiological standpoint. Issues with an open cavity include persistent discharge, dizziness from direct caloric stimulation of the semicircular canals by air or water entering the cavity, reliance on the surgeon for routine cleaning, challenges with hearing aid placement and an unattractive appearance due to an enlarged meatoplasty.<sup>7,8</sup> Therefore, to improve the long term stability of the mastoid cavity and to eliminate the cavity related problems significant modifications are introduced such as the mastoid obliteration technique. The concept of mastoid obliteration is first introduced by Mosher in 1911.<sup>9</sup> He describes the use of a superiorly based post auricular soft tissue flap for obliteration.<sup>10</sup> In obliterated mastoid cavities, there are very few complications compared to open cavities. Epithelialization is earlier and better in obliterated cavities. Hearing results are better in mastoid cavities with obliteration compared to open cavities. Patients with obliterated mastoid cavity need less cavity care and doctor dependence.<sup>11</sup> Mastoid cavity obliteration after CWD mastoidectomy gets rid of persistently discharging ear. Protection of lateral semicircular canal with bone and soft tissue allow patients to swim freely. Hearing aid fitting is easier and sound conduction by bone improves.<sup>12</sup> Over the course of the last decades, there have been a large number of reports detailing a multiplicity of techniques for obliterating the mastoid cavity. The most frequent and popular techniques

consist of either local flaps (muscle, periosteum, or fascia) or free autologous grafts (bone, cartilage, fat, fascia), or even alloplastic grafts (hydroxyapatite, silicon, synthetic bones etc).<sup>6</sup> This study compared the surgical outcomes among patients who had obliteration of mastoid cavity using vascularized periosteal-temporofascial swing, bone dust and cartilage for all participants to those who had open (unobliterated) mastoid cavity in terms of various post-operative cavity related issues.

## METHODS

This prospective longitudinal observational study was conducted in the department of otolaryngology-head and neck surgery of Sir Salimullah Medical College Mitford Hospital, with study subjects recruited from Sir Salimullah Medical College Mitford Hospital, Dhaka Medical College Hospital, and Bangladesh ENT Hospital between July 2023 and June 2024. A total of 80 patients undergoing canal wall down (CWD) mastoidectomy for active squamous chronic otitis media were enrolled purposively according to predefined selection criteria and divided into two groups by convenience sampling: group I (without obliteration) and group II (cavity obliteration), each containing 40 patients. Although the calculated minimum sample size using the standard statistical formula was 46.18 based on proportions reported by Bhardwaj et al, the final sample size was limited to 80 patients due to time constraints and patient availability.<sup>11</sup> Inclusion criteria included patients aged 10-40 years of either sex with evidence of active squamous chronic otitis media selected for CWD mastoidectomy, while patients below 10 years or above 40 years, those with malignancy, uncontrolled diabetes, immunosuppression, previous mastoidectomy, or bilateral disease were excluded. Variables studied included age, gender, discharging cavity, giddiness, epithelialization of mastoid cavity, wax formation after 3 months, preoperative and postoperative hearing levels, meatal stenosis, residual cholesteatoma, and facial nerve palsy. After obtaining informed written consent, detailed history taking, clinical examination, preoperative pure tone audiometry (PTA), intraoperative documentation, and postoperative assessments were carried out using a structured interviewer-administered questionnaire. Follow-up evaluations were conducted at the 3<sup>rd</sup> postoperative week and 3<sup>rd</sup> postoperative month to assess cavity discharge status, giddiness, epithelialization, wax formation, hearing outcome by PTA, and complications such as residual cholesteatoma and facial nerve palsy. Data were processed and analyzed using Microsoft Excel and SPSS version 26, presented as mean±standard deviation or percentages, and compared using Chi-square ( $\chi^2$ ) test and unpaired Student's t-test/z-test, with  $p < 0.05$  considered statistically significant. Operational definitions for cholesteatoma, canal wall up (CWU) mastoidectomy, canal wall down (CWD) mastoidectomy, cavity obliteration, PTA, surgical outcomes, and postoperative period were standardized for the study. Ethical approval was obtained from the research review committee and ethical review committee of Sir Salimullah Medical

College Mitford Hospital, and all participants were informed about the nature, risks, and benefits of the study. Participation was voluntary, confidentiality and anonymity were maintained through coded data storage in a locked cabinet accessible only to research personnel, and proper consent and patient privacy were ensured throughout the study.

## RESULTS

Mean age of the patients was almost same in both the two groups (27.92±8.23 years versus 27.28±8.19 years; p=0.724) (Table 1). Males were predominant than females in both the two groups.

**Table 1: Demographic profile of the study subjects (n=80).**

| Variables          | Group I    | Group II   | P value |
|--------------------|------------|------------|---------|
| <b>Age (years)</b> |            |            |         |
| 10-20              | 9 (22.5)   | 10 (25.0)  |         |
| 21-30              | 12 (30.0)  | 12 (30.0)  |         |
| 31-40              | 19 (47.5)  | 18 (45.0)  |         |
| Mean±SD            | 27.92±8.23 | 27.28±8.19 | a0.724  |
| <b>Gender</b>      |            |            |         |
| Male               | 26 (65.0)  | 29 (72.5)  | b0.631  |
| Female             | 14 (35.0)  | 11 (27.5)  |         |

a. Unpaired t test b. Chi-Square test was done.

**Table 2: Discharge status of mastoid cavity at various follow up visits.**

| Discharge       | Group I   | Group II  | P value |
|-----------------|-----------|-----------|---------|
| <b>3 weeks</b>  |           |           |         |
| Absent          | 25 (62.5) | 28 (70.0) | a0.478  |
| Present         | 15 (37.5) | 12 (30.0) |         |
| <b>3 months</b> |           |           |         |
| Absent          | 29 (72.5) | 38 (95.0) | b0.015  |
| Present         | 11 (27.5) | 2 (5.0)   |         |

a. Chi-Square test b. Fisher's Exact test was done.

In this study, the rate of cavity dryness was higher in group II, which had cavity obliteration. After three weeks, 70.0% of these cavities had become dry, compared to 62.5% in group I, which had open cavities. Over the final three months, 95.0% of the cavities in group II had dried, while 72.5% in group I were dry (Table 2). The difference was statistically significant at three months (p=0.015).

**Table 3: Giddiness after surgery at various follow up visits.**

| Giddiness       | Group I   | Group II  | P value |
|-----------------|-----------|-----------|---------|
| <b>3 weeks</b>  |           |           |         |
| Absent          | 25 (62.5) | 28 (70.0) | a0.478  |
| Present         | 15 (37.5) | 12 (30.0) |         |
| <b>3 months</b> |           |           |         |
| Absent          | 32 (80.0) | 39 (97.5) | b0.029  |
| Present         | 8 (20.0)  | 1 (2.5)   |         |

a. Chi-Square test and b. Fisher's Exact test was done.

In group I, giddiness was observed in 37.5% of patients and in group II 30.0% within a 3 weeks period. After three

months, it remained evident in 20.0% of patients in group I and 2.5% in group II (Table 3). The difference was statistically significant.

**Table 4: Epithelialisation of mastoid cavity at various follow up visits.**

| Epithelializations | Group I    | Group II   | P value |
|--------------------|------------|------------|---------|
| <b>3 weeks</b>     |            |            |         |
| Complete           | 0 (0.0)    | 0 (0.0)    |         |
| Incomplete         | 40 (100.0) | 40 (100.0) |         |
| <b>3 months</b>    |            |            |         |
| Complete           | 24 (60.0)  | 36 (90.0)  | 0.004   |
| Incomplete         | 16 (40.0)  | 4 (10.0)   |         |

Fisher's Exact test was done.

The study demonstrated that none of the cavities in group I and group II had completely epithelialized by the end of the third week. Within three months, 90.0% of cavities in group II were completely healed, while 60.0% in group I had healed. (Table 4). These findings indicate that obliteration promotes the early repair of the mastoid cavity. By the end of three months, the difference was significant (p=0.004).

**Table 5: Wax formation after surgery at 3<sup>rd</sup> month follow up visit.**

| Wax                         | Group I   | Group II  | P value |
|-----------------------------|-----------|-----------|---------|
| <b>3<sup>rd</sup> month</b> |           |           |         |
| Absent                      | 32 (80.0) | 38 (95.0) | 0.090   |
| Present                     | 8 (20.0)  | 2 (5.0)   |         |

Wax formation occurred in 20.0% of group I patients and 5.0% of group II after three months (Table 5). The difference between two groups was not statistically significant.

**Table 6: Comparison of preoperative and postoperative mean hearing levels and the hearing gain of the two groups in the study.**

| Audiological Assessments                     | Group I    | Group II   | P value |
|----------------------------------------------|------------|------------|---------|
| <b>Pre-op hearing loss (dB)</b>              | 56.18±3.90 | 56.05±4.21 | 0.891   |
| <b>Hearing threshold after 3 months (dB)</b> | 48.22±4.07 | 45.82±5.38 | 0.027   |
| <b>Hearing gain (dB)</b>                     | 7.95±3.68  | 10.22±5.42 | 0.031   |

Unpaired t test was done.

The post-operative hearing levels at three months for the two groups were as follows: group I had a mean hearing level of 48.22±4.07 dB, while group II had a mean of 45.82±5.38 dB, with a statistically significant difference (p=0.027). Additionally, hearing gain at three months post-

surgery was recorded at  $7.95 \pm 3.68$  dB for group I and  $10.22 \pm 5.42$  dB for group II (Table 6). The difference in hearing gain between the two groups was also statistically significant ( $p=0.031$ ). These findings indicate that patients who underwent cavity obliteration experienced better hearing improvements than those with an open cavity.

**Table 7: Comparison of preoperative and postoperative hearing outcome of the two groups in the study.**

| Hearing status | Group I   | Group II  | P value |
|----------------|-----------|-----------|---------|
| Improved       | 34 (85.0) | 35 (87.5) | 0.900   |
| Not improved   | 3 (7.5)   | 3 (7.5)   |         |
| Deteriorated   | 3 (7.5)   | 2 (5.0)   |         |

Chi-Square test was done.

There was no significant difference in hearing outcome between group I and group II (Table 7).

**Table 8: Post-operative complications in both groups.**

| Complications          | Group I  | Group II | P value |
|------------------------|----------|----------|---------|
| Meatal stenosis        | 6 (15.0) | 2 (5.0)  | 0.263   |
| Residual cholesteatoma | 3 (7.5)  | 1 (2.5)  | 0.615   |
| Facial nerve palsy     | 0 (0.0)  | 0 (0.0)  |         |

The incidence of postoperative complications was markedly reduced in group II relative to group I. Meatal stenosis was lower in group II (5.0%) than group I (15.0%). Residual cholesteatoma was found in three instances in group I and one instance in group II, suggesting that it is not contingent upon the surgical technique employed. Facial nerve palsy was not found in either group (Table 8).

## DISCUSSION

A total of 80 patients diagnosed with active squamous COM with cholesteatoma and scheduled for canal wall down mastoidectomy were selected according to predefined criteria. Patients were divided into two groups randomly: group I underwent surgery without cavity obliteration, while group II underwent surgery with cavity obliteration. Vascularized periosteal-temporofascial swing, bone dust and cartilage are used for all patients with cavity obliteration.

In this study, mean age of the patients was almost same in both the two groups ( $27.92 \pm 8.23$  years versus  $27.28 \pm 8.19$  years;  $p=0.724$ ). In contrast higher mean age of the patients ( $49.9 \pm 10.9$ , 45 years) have been reported in some studies.<sup>13,14</sup> This study enrolled patients aged 10 to 40 years, resulting in a lower mean age compared to other studies. In this study males were predominant than females in both the two groups which is consistent with other reports.<sup>13-15</sup>

In this study, the rate of cavity dryness was higher in group II, which had cavity obliteration. After three weeks, 70.0% of these cavities had become dry, compared to 62.5% in group I, which had open cavities. Over the final three months, 95.0% of the cavities in group II had dried, while 72.5% in group I were dry. The difference was statistically significant at three months ( $p=0.015$ ). Bhardwaj et al revealed that the cavities began becoming dry by 56% in 3 weeks in group 2 in comparison to 28% dry cavity in those with open cavity of group 1.<sup>11</sup> In the final six months, 96% cavity cavities had dried in the group 2, while only 88% were dry in group 1 cases. The gap was statistically significant at 3 weeks but later in the course of follow up it became non-significant.<sup>11</sup> Maheshwari et al revealed on follow up day 15, 15 (100%) patients complained of discharge in open mastoid cavity obliteration, whereas in mastoid cavity obliteration, 13 (86.6%) patients complained of discharge. On follow up day 45, 10 (66.67%) in open mastoid cavity obliteration and 3 (20%) in mastoid cavity obliteration complained of discharge ( $p<0.05$ ). At the end of the study, on follow up day 90, 5 (33.3%) in open mastoid cavity obliteration and 2 (13.3%) in mastoid cavity obliteration complained of discharge.<sup>16</sup> Deshmukh et al three months after surgery, of the 20 cases, 16 (80%) patients had a dry cavity whereas 4 (20%) patients still had ear discharge. Of the 20 control cases, 12 (60%) had a dry cavity and 6 (30%) still had ear discharge.<sup>17</sup>

In group I, giddiness was observed in 37.5% of patients and in group II 30.0% within a 3 weeks' period. After three months, it remained evident in 20.0% of patients in group I and 2.5% in group II. The difference was statistically significant. Bhardwaj et al found that the giddiness did not appear in all patients in group 2 following surgery.<sup>11</sup> However, in group 1, it was present in 12% patients within 3 weeks. At the end of six months, it was still present in the 8% of patients.<sup>11</sup> In the study of Maheshwari et al, on follow up day 15, 5 (33.3%) patients complained of giddiness in open mastoid cavity obliteration, whereas in mastoid cavity obliteration 2 (13.3%) patients complained of giddiness. On follow up day 21, 2 (13.3%) patients in open mastoid cavity obliteration and 2 (13.33%) in mastoid cavity obliteration complained of giddiness. On follow up day 45, 1 (6.66%) in open mastoid cavity obliteration and 1 (6.66%) in mastoid cavity obliteration complained of giddiness. At the end of the study, on follow up day 90 no patient complained of giddiness.<sup>16</sup>

This study demonstrated that none of the cavities in group I and group II had completely epithelialized by the end of the third week. Within three months, 90.0% of cavities in group II were completely healed, while 60.0% in group I had healed. These findings indicate that obliteration promotes the early repair of the mastoid cavity. However, by the end of three months, the difference was significant ( $p=0.004$ ). Bhardwaj et al demonstrated that 40.0% cavities had been completely epithelialized the patients in group 2 by the end third week, compared to 4.0% in group 1. 92% of cavities were healed completely within 6 months

in the case of group 2, compared with 72% of the healed cavities for the group 1.<sup>11</sup> This clearly demonstrated that obliteration promotes the early repair of the mastoid cavity because statistical significance was attained within 3 weeks at  $p=0.002$ .<sup>11</sup> In the study of Maheshwari et al average time for epithelialization in mastoid cavity obliteration was 5 weeks, whereas in open mastoid cavity obliteration was 16 weeks. At the end of study period, on follow up day 90, 10 (66.7%) cavities had complete epithelialisation in mastoid cavity obliteration. Whereas 4 (26.67%) cavities in open mastoid cavity obliteration had complete epithelialisation.<sup>16</sup> Chhapola et al shows 18 (90%) cases with obliteration technique had complete epithelialisation at the end of study period of 6 months, and 14 (70%) cases in open cavity.<sup>16</sup> Deshmukh et al found among the patients where cartilage and flap were used to obliterate mastoid cavity, epithelialisation had occurred in 60% of cases whereas where bone dust was used epithelialization had occurred in 40% of cases. Epithelialization had occurred in 80% of patients where cartilage and flap were used whereas 100% of patients showed epithelialisation with the use of bone dust for obliteration.<sup>17</sup>

Wax formation occurred in 20.0% of group I patients and 5.0% of group II after three months in this study. From the study of Bhardwaj et al, it was found that the formation of wax was observed in 12.0% of patients after 3 months, and 20.0% of patients at six months in group 1.<sup>11</sup> However, patients in group 2 were seen having wax formation in just 4.0% of patients at the end of the 6<sup>th</sup> month.<sup>11</sup> In the study of Maheshwari et al, at 90 days follow up, 1 (6.66 %) cases in mastoid cavity obliteration had waxy debris and 3 (20%) cases in open mastoid cavity obliteration.<sup>16</sup> Chhapola et al found at the end of study period 2 (10%) patients presented with wax in the control group.<sup>18</sup> Deshmukh et al. at the end of the study period found only 2 patients in the control group presented with waxy debris.<sup>17</sup>

The post-operative hearing levels at three months for the two groups were as follows: group I had a mean hearing level of  $48.22 \pm 4.07$  dB, while group II had a mean of  $45.82 \pm 5.38$  dB, with a statistically significant difference ( $p=0.027$ ). Additionally, hearing gain at three months post-surgery was recorded at  $7.95 \pm 3.68$  dB for group I and  $10.22 \pm 5.42$  dB for group II. The difference in hearing gain between the two groups was also statistically significant ( $p=0.031$ ). These findings indicate that patients who underwent cavity obliteration experienced better hearing improvements than those with an open cavity. But there was no significant difference in hearing outcome between group I and group II. Bhardwaj et al found that the post-operative hearing levels at 6 months was significantly higher in group 1 ( $33.68 \pm 2.59$  dB) than group 2 ( $25.16 \pm 1.31$  dB). The hearing gain at 6 months after surgery was significantly higher in group 2 than group 1 ( $13.24 \pm 4.80$  versus  $6.96 \pm 2.82$ ).<sup>11</sup>

The incidence of postoperative complications was markedly reduced in group II relative to group I. Meatal

stenosis was lower in group II (5.0%) than group I (15.0%). Residual cholesteatoma was found in three instances in group I and one instance in group II, suggesting that it is not contingent upon the surgical technique employed. Facial nerve palsy was not found in either group. Bhardwaj et al. revealed that post-operative complications were less in group II comparing group I.<sup>11</sup> Das and Hazra found common long term complication of obliteration appears to be recurrent cholesteatoma. They followed up 463 patients of mastoid obliteration using Palva flap for 5-15 years. Post-operative cholesteatoma was found in 22 patients (4.8%).<sup>12</sup> Chhapola and Matta stated that the incidence of pain, discharge, giddiness and wax formation was markedly reduced in obliterated cavities as compared to open cavities.<sup>18</sup>

This study has some limitations. This was a single-centred study with a limited age range, purposive sampling, short follow-up period, and variations in surgeons, instrumental setups, and obliteration materials, which may have influenced the outcomes.

## CONCLUSION

Cavity obliteration following canal wall down mastoidectomy was found to be a more effective surgical approach than leaving the mastoid cavity open. Patients who underwent cavity obliteration experienced reduced postoperative discharge, giddiness, and wax formation. The procedure also promoted earlier epithelialisation of the cavity and resulted in better postoperative hearing outcomes. Overall, mastoid cavity obliteration significantly improved postoperative recovery and enhanced the quality of life of the patients compared to non-obliterated cavities.

## Recommendations

Future studies should be conducted as multicentred research involving different cities to obtain more representative findings. Studies with a larger sample size and random sampling techniques are recommended to improve the validity and reliability of the results. A longer follow-up period is also necessary to evaluate the long-term outcomes of mastoid cavity obliteration. Inclusion of patients from all age groups would provide a broader understanding of the procedure's effectiveness. To minimise variations in surgical outcomes, future research should ideally involve surgeries performed by a single surgeon using a uniform instrumental setup.

Additionally, comparative studies evaluating different obliteration materials should be carried out to determine the most effective material in terms of postoperative outcomes.

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