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Frequency of Septal Perforation in Submucous Resection of Nasal Septum

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ABSTRACT

Deviated nasal septum (DNS) is a frequent cause of nasal obstruction and is commonly treated through submucous resection (SMR). Although effective, SMR carries a risk of septal perforation, which can lead to long-term morbidity. **Objectives:** To determine the frequency of septal perforation following submucous resection (SMR) of the nasal septum using the tunnel-in technique. **Methods:** This descriptive observational study was conducted at the Department of ENT, Lady Reading Hospital, Peshawar, from September 2024 to February 2025. A total of 203 patients aged 18–60 years undergoing SMR for symptomatic DNS were enrolled through consecutive non-probability sampling. Patients with prior nasal surgery, trauma, or coexisting nasal pathology were excluded. All surgeries were performed by ENT consultants using a standardized technique. Septal perforation was assessed via endoscopy on the 10th postoperative day. **Results:** Out of 203 patients, 43 (21.2%) developed septal perforation. The mean age was 38.96 ± 12.74 years; the mean disease duration was 19.52 ± 10.46 months. Perforation showed a significant association with gender (p=0.005) and age group (p=0.025), while no significant link was found with the side of deviation or disease duration. **Conclusions:** Septal perforation was a relatively common postoperative complication of SMR, with higher occurrence in females and older individuals. Careful patient selection and surgical precision are key to reducing risk.

INTRODUCTION

The surgical correction of a deviated nasal septum has evolved significantly over the decades [1]. In 1929, Metzenbaum developed one of the earliest approaches focused on manipulating the caudal septum, then Peer in 1937 suggested straightening and repositioning the septum to the midline. Such endeavours have contributed to what is now referred to as Submucous Resection (SMR), one of the classical techniques employed for dealing with surgically correctable deviated septa [2]. Deviated nasal septum (DNS) presents one of the most common conditions encountered in otorhinolaryngology clinics and continues to be a principal reason for undergoing nasal surgery. It is associated with symptoms such as breathing difficulty through the nose, chronic headaches, and postnasal drainage. In practice, management of DNS is algorithm-based towards surgical options, whether it be conventional or endoscopic. Despite the existence of more modern techniques, submucous resection persists as the go-to approach because of ease and effectiveness when treating substantial deviations [3]. Killlan *et al.* advanced the idea of SMR by highlighting submucosal access along with tissue conservation.Nevertheless, complications such as septal perforation led to a move towards more conservative approaches like septoplasty.Despite this change, SMR continues to be relevant in many settings because of its effectiveness, especially when performed

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using the tunnelling technique by experienced surgeons [4]. Numerous researchers have focused on the disadvantages of SMR surgery, especially concerning the potential postoperative complications. A. Gravina *et al.* showed that inadequate visibility in the traditional approaches, as compared to endoscopy, may lead to increased trauma of the mucosa layer due to limited or inadequate scrutiny, increasing the chances for septal perforations [5]. This also explains why Garg and colleagues has endorsed endoscopic methods because they have a far greater degree of visualization and therefore accuracy as well as precision [6]. Reported rates of septal perforation differ widely among studies, ranging from 2.2% to 5%. This variability can be attributed to multiple factors, including the type of surgical technique (traditional SMR vs. endoscopic septoplasty), experience of the surgeon, and duration of postoperative follow-up. For instance, endoscopic techniques tend to yield lower complication rates due to enhanced visualization, while short follow-up intervals may underreport delayed perforations. Alrobian *et al.* documented rates of 2.2% and 3.2% [7], while Al Sulaiti *et al.* noted a 2.5% incidence following submucous resection. Sarin *et al.* observed a 5% rate with postoperative splint use [8]. Septal perforations, although sometimes asymptomatic, can cause whistling sounds during breathing, nasal crusting, epistaxis, and a sensation of nasal blockage. The purpose of this study was to assess the frequency of septal perforation in patients undergoing. To quantify such symptoms and their impact on quality of life, validated scoring systems such as the NOSE (Nasal Obstruction Symptom Evaluation) scale and the Visual Analogue Scale (VAS) have been widely used in literature. Several studies have demonstrated that septal perforation can lead to significantly higher NOSE scores, indicating worse nasal function and patient-reported outcomes [6].

This study aims to assess the frequency of septal perforation in patients undergoing SMR using the tunnelling technique by experienced ENT surgeons. By focusing on identifying associated demographic and surgical risk factors, this study aims to provide insight into optimizing surgical techniques and reducing postoperative complications. Understanding the prevalence and predictors of this complication may help refine surgical protocols and improve patient outcomes.

METHODS

This research was structured as a descriptive, observational study conducted at the Department of ENT, Lady Reading Hospital, Peshawar. This study aims to determine the frequency of septal perforation following submucous resection of the nasal septum (SMR). The study extended from September 2024 to February 2025. Before initiating data collection, ethical clearance was obtained from the Institutional Review Board (IRB) of Lady Reading Hospital, Medical Teaching Institution (MTI), Peshawar. The approval was issued under Ref. No. 972/LRH/MTI, certifying that the study met all ethical requirements. Furthermore, the synopsis was formally approved by the Research Evaluation Unit (REU) of CPSP, under Ref No: CPSP/REU/ENT-2022-022-1394. A consecutive non-probability sampling method was utilized. Every patient who was eligible and fulfilled the inclusion criteria during the study period was enrolled in a sequential manner until the required sample size was reached. The required sample size was calculated using the World Health Organization (WHO) sample size calculator. Considering a 5% expected frequency of septal perforation [9], with a 95% confidence level and a 3% margin of error, the final calculated sample size was 203 participants. The 3% margin of error was selected to allow for a narrower confidence interval around the estimated prevalence [9], improving precision. A formal power analysis was not conducted, as the primary aim of this study was to estimate prevalence rather than test a specific hypothesis. The study protocol received ethical clearance from the institutional review committee. All patients gave appropriate informed written consent before participating. Each patient was informed of the study aims, steps involved, and their option to withdraw at any stage without any impact on their healthcare. Inclusion Criteria were defined as follows: participants were enrolled if they were within the age range of 18–60 years, of either gender, and diagnosed with symptomatic deviated nasal septum scheduled for SMR via the Outpatient Department (OPD). The study excluded patients presenting with additional nasal pathologies such as nasal polyps or chronic rhinosinusitis, as well as individuals with a history of previous nasal surgeries or traumatic nasal injuries. These criteria were essential to minimize confounding variables that could skew the assessment of septal perforation outcomes. After obtaining informed consent, participants' demographic details and clinical history were recorded on a standardized proforma. All patients were evaluated for signs of previous nasal trauma or surgery. Preoperative imaging was performed using computed tomography (CT) of the paranasal sinuses (CT PNS). The scans were reviewed for features such as mucosal thickening, sinonasal polyps, sinus opacification, air-fluid levels, bony erosions, mucoceles, and anatomical variants like concha bullosa. Only patients with normal sinus anatomy and no coexisting pathology were included. All SMR procedures were conducted by experienced ENT consultants. The surgical approach involved raising a mucoperichondrial flap using a freer elevator under direct visualization. The deviated portion of the nasal septal cartilage was excised using Luc's forceps. Surgical adequacy was confirmed by midline repositioning of

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mucosal flaps and by bilateral nasal cavity inspection for residual deviation. Although no formal intraoperative checklist was used, a standardized operative protocol was followed for every case. This included bilateral tunnelling technique, careful elevation of mucoperichondrial flaps, minimal cartilage excision, and consistent use of nasal splints to protect flap positioning. All surgeries were performed by the same surgical team to ensure consistency. Once correction was ensured, the mucosal flaps were repositioned without sutures and secured using bilateral nasal splints, fixed with 1/0 silk through-and-through sutures. The nasal cavities were packed with polyfax ointment-soaked gauze. Post-operative instructions included saline nasal douching, avoidance of nose blowing, and pain control with paracetamol. Endoscopic evaluation for septal perforation was performed on the 10th postoperative day, coinciding with the removal of nasal splints. This timing was selected as most early perforations, if present, would become clinically apparent by this point due to mucosal necrosis or incomplete healing. While delayed perforations can occur, the 10th day was standardized across all cases to ensure uniformity of follow-up. To ensure reliability, data collection was performed using a structured and pre-validated proforma, and all assessments (pre- and post-operatively) were conducted by the same surgical team to reduce inter-observer variability. Surgical protocols were standardized. Validity was reinforced by excluding patients with potential confounding factors, using imaging (CT PNS) and direct endoscopic visualization to confirm diagnosis and outcomes. Data entry was double-checked by an independent reviewer. Data were analyzed using SPSS version 20.0. Categorical variables such as gender, presence of septal perforation, side of deviation, and grouped age and disease duration were expressed as frequencies and percentages. Continuous variables like age and duration of disease were summarized using mean ± standard deviation, along with minimum and maximum values. Chi-square tests were applied to assess associations between septal perforation and demographic or clinical factors. A p-value≤0.05 was considered statistically significant. Post-stratification was conducted for effect modifiers, and the strength of associations was measured using Cramer's V. Additionally, binary logistic regression was performed to identify independent predictors of septal perforation, with adjusted odds ratios (AORs) and 95% confidence intervals reported. Results were presented in tabular and graphical formats for clarity and comparison with a 95% confidence level and a 3% margin of error, the final calculated sample size was 203 participants. The study protocol received ethical clearance from the institutional review committee. All patients gave appropriate informed written consent before participating.

Each patient was informed of the study aims, steps involved, and their option to withdraw at any stage without any impact on their healthcare. Inclusion Criteria were defined as follows, where subjects were enrolled if: Participants were within the age range 18 -60 years old. both male and female. And patients diagnosed with symptomatic deviated nasal septum who were admitted via the Outpatient Department (OPD) and scheduled for SMR. The study excluded patients presenting with additional nasal pathologies such as nasal polyps or chronic rhinosinusitis. And individuals with a history of previous nasal surgeries or traumatic nasal injuries. These criteria were essential to minimize confounding variables that could skew the assessment of septal perforation outcomes. After obtaining informed consent, participants' demographic details and clinical history were recorded on a standardized proforma. All patients were evaluated for signs of previous nasal trauma or surgeries. Imaging, including CT scan of the paranasal sinuses (PNS), was performed to rule out coexisting sinus disease and assess nasal anatomy. All SMR procedures were conducted by experienced ENT consultants. The surgical approach involved raising a mucoperichondrial flap using a freer elevator, under direct visualization. The deviated portion of the nasal septal cartilage was excised using Luc's forceps. Surgical adequacy was confirmed by midline repositioning of mucosal flaps and by bilateral nasal cavity inspection for residual deviation. Once correction was ensured, the mucosal flaps were repositioned without sutures and secured using bilateral nasal splints, fixed with 1/0 silk through-and-through sutures. The nasal cavities were packed with polyfax ointment-soaked gauze. Post-operative instructions included saline nasal douching, avoidance of nose blowing, and pain control with paracetamol. Splints were removed on the 10th post-operative day, and nasal endoscopy was performed to detect any signs of septal perforation. To ensure reliability, data collection was performed using a structured and pre-validated proforma, and all assessments (pre- and post-operatively) were conducted by the same surgical team to reduce inter-observer variability. Surgical protocols were standardized. Validity was reinforced by excluding patients with potential confounding factors. Using imaging (CT PNS) and direct endoscopic visualization to confirm diagnosis and outcomes. Data entry was double-checked by an independent reviewer. Data were analyzed using SPSS version 20. Categorical variables such as gender, presence of septal perforation, side of deviation, and grouped age and disease duration were expressed as frequencies and percentages. Continuous variables like age and duration of disease were summarized using mean ± standard deviation, along with minimum and maximum values. Chi-square tests were applied to assess associations between

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septal perforation and demographic or clinical factors. A p-value≤0.05 was considered statistically significant. Post-stratification was conducted for effect modifiers, and the strength of associations was measured using Cramer's V. Results were presented in tabular and graphical formats for clarity and comparison.

RESULTS

Out of the 203 patients included in this study, the gender distribution was slightly skewed toward female, with 108 (53.2%) female and 95 (46.8%) male. The mean age of the participants was 38.96 ± 12.74 years, ranging from 18 to 60 years. On average, patients had experienced nasal obstruction symptoms for 19.52 ± 10.46 months, with durations ranging from 1 month to 36 months. Postoperatively, septal perforation was detected in 43 patients, yielding a prevalence of 21.2%. The 95% confidence interval for this prevalence was 15.4% to 26.9%, providing a statistically sound estimate of the true rate of this complication in the study population (Table 1).

Table 1: Demographics and Septal Perforation Frequency (n=203)

Parameters	Category / Value	Frequency (%)	Range
Gender	Male	95 (46.8%)	–
	Female	108 (53.2%)	–
Age (Years)	Mean ± SD	38.96 ± 12.74	18 - 60
Duration of Disease	Mean ± SD	19.52 ± 10.46	1 - 36 Months
Septal Perforation	Yes	43 (21.2%)	–
	No	160 (78.8%)	–
95% CI for Perforation	–	15.4% - 26.9%	–

A statistically significant association was found between gender and the occurrence of septal perforation. Among the 95 male patients, 12 (12.6%) developed perforation, while 31 out of 108 female patients (28.7%) were affected. The difference was significant (χ^2 = 7.820, p=0.005), with a Cramer's V value of 0.196 indicating a moderate strength of association. These findings suggest that females had a higher risk of developing septal perforation following submucous resection. When patients were grouped by age, a statistically significant trend emerged (χ^2 = 7.414, p 0.025). Only 6 (9.8%) patients aged 18–30 years developed septal perforation. This rose to 17 (23.3%) in the 31–45 age group and peaked at 20 (29.0%) among those aged 46–60 years. These results highlight a clear increase in risk with advancing age, suggesting that older patients may be more susceptible to mucosal injury or impaired healing (Table 2).

Table 2: Association Between Gender and Septal Perforation, Age Group and Septal Perforation

Variables	Perforation: Yes	Perforation: No	Chi-square (χ^2)	p-Value	Cramer's V
Gender					
Male	12 (12.6%)	83 (87.4%)	7.820	0.005	0.196
Female	31 (28.7%)	77 (71.3%)			
Age Group (Years)					
18–30	6 (9.8%)	55 (90.2%)	7.414	0.025	0.191
31–45	17 (23.3%)	56 (76.7%)			
46–60	20 (29.0%)	49 (71.0%)			

Analysis of the relationship between the side of nasal septal deviation and septal perforation revealed no statistically significant association (χ^2 = 1.469, p 0.226). Among patients with left-sided deviation, 20 (18.0%) developed perforation compared to 23 (25.0%) of those with right-sided deviation. Despite this numerical difference, the lack of statistical significance indicates that the laterality of deviation may not influence the risk of postoperative perforation. An analysis of the duration of nasal symptoms revealed no significant association with the development of septal perforation (χ^2 = 1.062, p=0.588). Twelve patients with symptoms lasting less than 12 months (19.0%) developed perforation, as did 12 patients (18.8%) with 12–24 months of disease and 19 patients (25.0%) with symptoms persisting beyond 24 months. Although there was a mild upward trend with longer symptom duration, it was not statistically meaningful (Table 3).

Table 3: Association Between Side of Deviation and Septal Perforation, Duration of Disease and Septal Perforation

Variables	Perforation: Yes	Perforation: No	Chi-square (χ^2)	p-Value
Side of Deviation				
Left	20 (18.0%)	91 (82.0%)	1.469	0.226
Right	23 (25.0%)	69 (75.0%)		
Duration (Months)				
<12	12 (19.0%)	51 (81.0%)	1.062	0.588
12–24	12 (18.8%)	52 (81.2%)		
>24	19 (25.0%)	57 (75.0%)		

To assess whether age, gender, side of septal deviation, and duration of disease were independent predictors of septal perforation, a binary logistic regression analysis was performed. The model was statistically significant (χ^2 = 20.227, df=6, p=0.003), indicating that the included variables meaningfully predicted the likelihood of perforation. The Hosmer–Lemeshow goodness-of-fit test was non-significant (p=0.101), suggesting that the model fit the data well. The Nagelkerke R^2 value was 0.147, showing that approximately 14.7% of the variation in septal perforation was explained by the model. The classification accuracy improved to 81.3% with the inclusion of predictors. After adjusting for all covariates, female gender emerged as a significant independent predictor of septal perforation, with females having higher odds of developing perforation compared to males (AOR = 0.338; 95% CI: 0.157–0.730; p=0.006). Similarly, age group 31–45 years was significantly associated with increased risk (AOR = 4.498; 95% CI: 1.579–12.816; p=0.005) when compared to the reference age group of 18–30 years. However, the 46–60-

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year group did not show a statistically significant association (AOR = 1.471; p=0.340). The side of septal deviation (right vs. left) was not significantly associated with perforation in the adjusted model (AOR = 1.678; p=0.168), nor was duration of disease. Both duration categories (12–24 months and >24 months) did not show statistically meaningful differences in risk when compared to those with disease duration less than 12 months. These results suggest that female gender and middle-aged patients (31–45 years) are at greater risk for septal perforation following submucous resection, independent of anatomical laterality or symptom duration (Table 4).

Table 4: Multivariable Logistic Regression Predicting Septal Perforation (n=203)

Predictor Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-Value
Gender			
Female	0.338	0.157 – 0.730	0.006 **
Septal Deviation Side			
Right	1.678	0.804 – 3.505	0.168
Age Group			0.019 **
31–45 Years	4.498	1.579 – 12.816	0.005 **
46–60 Years	1.471	0.666 – 3.251	0.340
Duration of Disease			0.333
12–24 Months	0.943	0.363 – 2.446	0.904
>24 Months	0.552	0.227 – 1.342	0.190

Reference categories: Gender = Male; Septal Deviation Side = Left; Age = 18–30 years; Duration = <12 months. AOR: Adjusted Odds Ratio; CI: Confidence Interval. Bolded p-values < 0.05 indicate statistical significance.

The occurrence of septal perforation increases progressively with age. The lowest rate of perforation was observed in the 18–30 age group (6 cases), while the highest was seen in patients aged 46–60 years (20 cases). In contrast, the number of patients without perforation decreases slightly with age. A chi-square analysis confirmed that the difference in perforation rates between age groups was statistically significant (p=0.025), suggesting a potential link between older age and higher risk of septal perforation following submucous resection. The chart illustrates the frequency of septal perforation among three age groups (18–30, 31–45, and 46–60 years). Each group displays the number of patients who developed septal perforation (blue bars) versus those who did not (orange bars). (Figure 1).

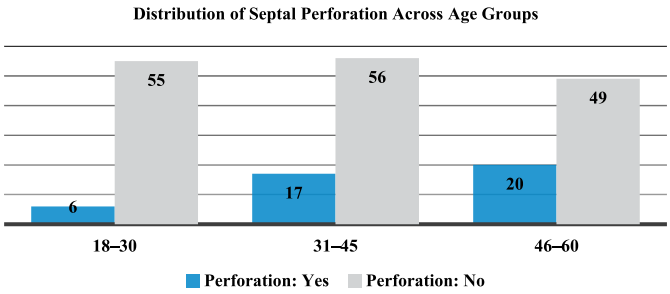

Figure 1: Distribution of Septal Perforation Across Age Groups

DISCUSSION

This study aimed to determine the frequency and associated factors of septal perforation following submucous resection (SMR) in patients with symptomatic deviated nasal septum. Out of 203 patients, a perforation rate of 21.2% was noted, which was substantially higher than most previously reported rates, typically ranging from 1% to 10%. This discrepancy may reflect variations in surgical technique, patient selection, and follow-up protocols, and indicates that despite SMR being considered a standard procedure, it continues to pose significant complication risks in some patient groups. Earlier studies on septal perforation reported rates between 1% and 5%. Eren *et al.* reported a 2.7% prevalence of perforations post-septoplasty [10], while Davis *et al.* noted a 3.5% rate in their retrospective study [11]. Similarly, Behery *et al.* described a 5% occurrence and advocated for splint wear to reduce mucosal injury and adhesion formation during postoperative healing [12]. Research conducted by Bansberg and Miglani highlighted that mucoperichondrial preservation alone does not guarantee protection from perforation and that improper dissection can increase risk [13]. Likewise, Pai *et al.* emphasized that older patients undergoing bilateral flap elevation are particularly prone to iatrogenic mucosal injury if not meticulously managed [14]. These findings support our study's observation that perforation was significantly associated with age over 45 years (p=0.025). Our analysis also showed that female gender was significantly associated with higher perforation rates (28.7% in females vs. 12.6% in male). Although limited studies have focused on gender-based healing differences, Khan, suggested that hormonal influences and mucosal sensitivity may contribute to differential healing patterns between male and female [15]. Further research is needed to determine whether these are biologically driven or related to behavioral differences in postoperative care compliance. No statistically significant association was observed between the side of septal deviation and the occurrence of perforation (p=0.226), in agreement with Blioska, who noted that the laterality or angle of deviation did not influence complication rates when a consistent surgical

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technique was applied [16]. Perforation risk also showed a clear age-related trend. Perforation rates increased progressively with advancing age. This supports findings by Noor *et al.* who noted that reduced mucosal thickness and vascularity in older adults may impair wound healing [17]. Gan *et al.* similarly found that complication rates increase in patients over 40 due to decreased tissue elasticity and delayed mucosal regeneration [18]. In contrast, duration of nasal symptoms was not associated with perforation risk, as also noted by Khaled *et al.* who found no relationship between symptom duration and mucosal healing in SMR [19]. This suggests that intraoperative tissue condition, rather than chronicity of symptoms, may be a more relevant factor for predicting outcomes. All procedures in this study were performed using a standardized method involving bilateral mucoperichondrial flap elevation, cartilage resection using Luc's forceps, and application of polyfax-soaked packing with splints. According to Park *et al.* meticulous flap elevation and the use of splints significantly reduce the risk of perforations [20]. Huang *et al.* emphasized the role of routine postoperative endoscopic surveillance in early detection of mucosal complications [21]. The use of bilateral nasal splints for 10 days in this study aligns with best practice protocols and appears to have minimized trauma during early healing. Although intraoperative mucosal tears were not formally recorded as a variable in our data collection tool, the surgical team monitored for such events during dissection. Anecdotally, most cases with visible flap damage were closely observed, but no direct correlation was statistically analyzed between intraoperative tears and postoperative perforation. This has been acknowledged as a limitation of the study. This study's higher-than-expected rate of septal perforation underscores the importance of surgical precision, intraoperative vigilance, and tailored postoperative care, especially in higher-risk groups such as older adults and female patients. While many findings align with the existing literature, some, particularly the gender disparity, require further prospective investigation.

CONCLUSIONS

This study found a septal perforation rate of 21.2% following submucous resection (SMR) of the nasal septum. A statistically significant association was observed between septal perforation and both age and gender, with female patients and those in older age groups being more prone to this complication. In contrast, the side of septal deviation and duration of disease were not significantly associated with perforation outcomes. These findings suggest that demographic variables, particularly gender and age, may influence the risk of postoperative septal perforation in patients undergoing SMR, even when a standardized surgical technique is applied.

Authors Contribution

Conceptualization: NZ
Methodology: KH, NU, JK
Formal analysis: NZ, HURA, KH, NU, JK
Writing review and editing: NZ, HURA, NU, JK

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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