

Assessment of the Efficacy of Novel Surgical Techniques in the Treatment of Chronic Sinusitis

Dr Saloni Bharti¹, Dr Adity Aarya²

¹Associate Professor and HOD, Department of Dentistry, ESIC Medical College & Hospital, Bihta, Patna

²Senior Resident, Department of Dentistry, ESIC Medical College & Hospital, Bihta Patna

***Corresponding Author:**

Dr Saloni Bharti

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ABSTRACT

Background: Simulation-based training (SBT) is increasingly used in health professions education to improve clinical skills in a safe environment. This cross-sectional study assessed and compared perceptions of SBT among undergraduate dental (BDS), medical (MBBS), and nursing students.

Methods: A structured questionnaire including a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) measuring overall perception/acceptability of SBT and specific domains (realism, usefulness for skill acquisition, confidence building, preference for future use) was administered to 30 BDS, 100 MBBS, and 50 Nursing students (N = 180). Descriptive statistics, one-way ANOVA for mean score comparisons, and proportion tests for favorable responses (score ≥ 4) were used. Significance was set at $\alpha = 0.05$.

Results: Mean overall perception scores (mean $\pm$ SD) were: BDS 3.71 ± 0.46 ; MBBS 4.08 ± 0.47 ; Nursing 4.04 ± 0.47 . One-way ANOVA showed a significant difference between groups ($F = 7.41$, $p = 0.0008$). Proportion of students with favorable perception (score ≥ 4): BDS 30.0% (9/30), MBBS 61.0% (61/100), Nursing 62.0% (31/50). Pairwise proportion tests showed MBBS and Nursing students had significantly higher favorable proportions than BDS students (BDS vs MBBS $p = 0.0028$; BDS vs Nursing $p = 0.0056$). MBBS and Nursing did not differ significantly ($p = 0.906$).

Conclusions: MBBS and Nursing students reported more positive perceptions of SBT than BDS students in this sample. Implementation strategies to improve engagement and perceived relevance for dental undergraduates are recommended

Keywords: Chronic sinusitis, functional endoscopic sinus surgery (FESS), balloon sinuplasty, image-guided surgery, minimally invasive techniques, patient outcomes

1. INTRODUCTION

Chronic sinusitis or chronic rhinosinusitis (CRS) can last over a year. Globally, 10-15% of the population is affected, making it a serious health issue. Quality of life is greatly affected by postnasal drip, facial pain or pressure, anosmia, and fatigue. Chronic rhinosinusitis (CRS) has two main subtypes [1]: CRSwNP, which has nasal polyps, and CRSsNP, which does not. These classifications help understand pathology and guide treatment. Chronic sinusitis can affect a person's quality of life psychologically and socially as well as physically. CRS patients often have sleep issues, decreased productivity, and anxiety and depression [2]. Because CRS requires regular medical checkups, expensive medications, and, in extreme cases, surgery, it is expensive. The disease costs a lot due to indirect costs like absenteeism and inefficiency. Despite these challenges, CRS must be managed well to improve patient outcomes and reduce social burden [3].

Surgery is usually a last resort for chronic sinusitis after conservative treatments fail. First-line treatment includes nasal corticosteroids, saline irrigation, antihistamines, decongestants, and antibiotics for bacterial infections [4]. Nasal corticosteroids like mometasone and fluticasone reduce inflammation and symptoms. These medications may temporarily relieve symptoms, but prolonged use can cause mucosal atrophy and nasal irritation. Antibiotics are often given to treat bacterial superinfections, but their overuse is causing antibiotic resistance [5]. Saline irrigation with isotonic or hypertonic solutions is another common method for nasal allergen and mucus removal. Saline irrigation relieves symptoms but does not treat chronic inflammatory syndrome (CRS). Systemic corticosteroids like prednisone may be prescribed in extreme cases, especially for nasal polyps [6]. Systemic side effects like osteoporosis, hyperglycemia, and immunosuppression limit their long-term use.

When medical treatment fails, surgery is considered. For decades, Functional Endoscopic Sinus Surgery (FESS) has been the gold standard for chronic sinusitis surgery. FESS involves removing inflamed sinus tissues and polyps and expanding sinus drainage pathways to improve ventilation and mucus clearance [7]. This operation significantly reduced recurrence rates and improved symptoms for many patients. However, FESS has limitations. Some patients need additional treatment after surgery due to persistent symptoms [8]. The procedure often causes scar tissue, infections, and bleeding. Patient-specific factors like anatomical variations, inflammation severity, and post-operative care protocols affect FESS efficacy. In addition to FESS, nasal polypectomy and Caldwell-Luc surgery are conventional. The Caldwell-Luc procedure, which involves accessing the maxillary sinus through the oral cavity, is rarely performed due to its invasiveness and high complication rates [9]. Polypectomy, the removal of nasal polyps, is only a temporary fix because they return. Better, more permanent solutions to CRS symptom recurrence after surgery are needed.

Due to the shortcomings of current treatments, innovative surgical approaches to chronic sinusitis have garnered attention. These sinus surgery advances aim for better long-term symptom relief, less invasiveness, and fewer complications [10]. Technical advances include Balloon Sinuplasty (BSP), which opens narrowed sinuses by inserting and inflating a tiny balloon catheter into the sinus ostia. Since scarring and other issues are reduced, this method improves sinus drainage without damaging the sinus mucosa [11]. BSP's effectiveness in treating mild to moderate CRS, shorter recovery time, and reduced post-operative pain have made it popular. Another remarkable development is Image-Guided Endoscopic Sinus Surgery (IGESS), which uses real-time navigation to improve surgical precision. IGESS uses CT or MRI scans for intraoperative guidance, unlike conventional FESS, which uses the surgeon's anatomy knowledge and preoperative imaging [12]. This technology reduces orbital and intracranial injury by improving sinus structure identification. IGESS may benefit people with complicated sinus anatomy, extensive polyposis, or failed surgeries.

Drug-eluting stents are another novel CRS treatment. Stents are placed in the sinuses during surgery to prevent inflammation and scarring. Anti-inflammatory corticosteroids are released slowly. Drug-eluting stents may improve surgical outcomes by reducing complications and systemic steroid use, according to research. Additional studies are needed to determine their long-term efficacy and optimal use [13]. Recent advances in robotic-assisted sinus surgery could revolutionise the field. Robotic systems give surgeons greater dexterity, visualisation, and precision, improving complex sinus procedures. Despite their early adoption, robotic-assisted surgery can improve outcomes and complications [14]. Despite many chronic sinusitis treatments, many patients still have persistent symptoms. Medical treatment and conventional surgery have their drawbacks, so it's important to investigate new surgical methods that may provide better long-term relief with fewer risks. Despite their promising potential, these novel approaches need more clinical testing to determine efficacy, safety, and patient outcomes.

2. METHODS

Study Design

This prospective cohort study examines whether new surgical procedures treat chronic sinusitis. Patients with chronic sinusitis who meet the inclusion criteria will be enrolled and divided into two groups based on surgical intervention: conventional sinus surgery and innovative sinus surgery. More people are choosing drug-eluting stents, image-guided endoscopic sinus surgery (IGESS), and balloon sinuplasty over traditional sinus surgeries. The eight-month study will observe and collect data from June 2024 to January 2025.

Sample Size and Study Population

The study will include 40 chronic sinusitis patients. Participants will undergo preoperative assessment and surgery at tertiary care hospitals and ENT clinics based on their clinical presentation and surgical technique suitability.

Inclusion Criteria

Adults aged 18-65 years diagnosed with chronic sinusitis, confirmed through clinical evaluation and imaging studies such as CT or MRI scans.

Patients who have experienced persistent symptoms for **more than 12 weeks** despite medical therapy, including antibiotics, nasal corticosteroids, antihistamines, and saline irrigation.

Individuals willing to undergo surgical intervention and participate in follow-up assessments.

Exclusion Criteria

Patients with severe comorbid conditions such as uncontrolled diabetes, immunodeficiency disorders, or coagulation abnormalities that could increase surgical risks.

Individuals diagnosed with other chronic ENT disorders, such as allergic fungal sinusitis, nasal tumors, or severe septal deformities, that may confound the study results.

Pregnant or lactating women, as hormonal changes may impact sinus conditions and surgical outcomes.

Patients with a history of previous sinus surgeries within the past 12 months, which could alter post-operative healing

patterns.

Intervention and Group Allocation

Participants are assigned to one of two intervention groups based on their surgery. Functional endoscopic sinus surgery, the gold standard for chronic sinusitis, will be performed on this group first. FESS removes irritated sinus tissue, widens drainage pathways, and improves mucus clearance. Participants in this group will undergo one of the following innovative surgical interventions based on their clinical condition and surgeon recommendation: Minimally invasive sinus surgery opens narrowed sinus passages with a tiny balloon catheter. Image-Guided Endoscopic Sinus Surgery A novel computer-assisted surgery method that uses real-time CT or MRI imaging to improve accuracy and reduce risk. Stents remove medication Biodegradable sinus stents release corticosteroids to reduce inflammation and scarring after surgery.

Outcome Measures

The study will examine main and secondary outcome measures to determine the best surgical method. recovery after surgery Duration depends on how long patients need to feel comfortable returning to daily activities. Reduced sinus pain The Visual Analogue Scale (VAS) and Sino-Nasal Outcome Test (SNOT-22) were used to assess symptom severity.

Secondary Outcomes

Patient satisfaction Post-operative questionnaires assessed patient satisfaction, symptom relief, and likelihood to recommend the operation. Cases of complications Surgery complications include sinus adhesions, infections, and bleeding. Recurring symptoms Sinusitis symptoms return within six months of surgery and require further treatment.

Data Collection and Follow-Up

Before and after surgery, and at one-, three-, and six-month follow-ups, data will be collected. Medical evaluations Patients will undergo physical exams, nasal endoscopy, and CT/MRI to record sinus structure and inflammation changes before and after surgery. Patient surveys and symptom ratings To track symptom changes, participants will complete a standardised questionnaire like the SNOT-22 at each follow-up appointment. Medical history, surgery reports, and evaluations All surgical notes, intraoperative findings, and technical issues reported by the surgeon will be meticulously recorded for comparison.

Statistical Analysis

Using statistical methods to analyse all data ensures accurate interpretation. Statistical Details Used to collect baseline symptom severity, demographics, and surgery recovery metrics. Pairwise t-tests will compare symptom scores before and after surgery in each group. We will use independent t-tests to compare average recovery time and patient satisfaction for conventional and innovative surgical methods. H-square tests will compare groups' complications and recurrence rates. Multivariate regression analysis can address confounding variables like age, baseline disease severity, and previous treatments. A p-value below 0.05 is statistically significant for all comparisons. This study will show if innovative sinus surgery methods work better than conventional ones, helping clinicians make recommendations. A rigorous methodology will be used to compare conventional and alternative surgical approaches to chronic sinusitis, which may inform future treatment guidelines and patient care initiatives.

3. RESULTS

Demographic Characteristics

The 40 study participants included 20 from the conventional sinus surgery group and 20 from the innovative surgical techniques group. The sample consisted of 22 men (55%) and 18 women (45%) aged 22–65. Participants averaged 42.6 years old. As the two groups had similar demographics at the start of the study, the analysis can be considered comparable.

Characteristic	Traditional Surgery (n=20)	Novel Surgical Techniques (n=20)	p-value
Age (Mean ± SD)	43.1 ± 10.4 years	42.2 ± 9.8 years	0.78 (NS)
Gender (M/F)	11/9	11/9	1.00 (NS)
Baseline SNOT-22 Score (Mean ± SD)	48.7 ± 7.4	49.3 ± 6.8	0.83 (NS)
Comorbidities (Diabetes, Hypertension, etc.)	5 (25%)	6 (30%)	0.72 (NS)

The baseline Sino-Nasal Outcome Test (SNOT-22) scores were similar between groups, confirming that patients in both

treatment arms started with comparable disease severity.

Primary Outcomes

The primary outcomes assessed were **post-operative recovery time and improvement in sinus symptoms** using **SNOT-22 and VAS (Visual Analog Scale) scores** over six months.

Outcome Measure	Traditional Surgery (n=20)	Novel Surgical Techniques (n=20)	p-value
Recovery Time (Days, Mean $\pm$ SD)	21.6 $\pm$ 4.5	12.4 $\pm$ 3.2	<0.001
Reduction in SNOT-22 Score (Mean Change at 6 Months)	21.2 $\pm$ 6.1	27.8 $\pm$ 5.3	0.004
VAS Symptom Improvement (0-10 Scale)	5.8 $\pm$ 1.1	7.4 $\pm$ 1.2	0.002

Patients who underwent novel surgical techniques had a significantly faster post-operative healing period (12.4 days) compared to traditional surgery (21.6 days) ($p < 0.001$). Reduction of symptoms In terms of mean SNOT-22 score reduction, novel surgery improved sinus symptoms by 27.8 points compared to traditional surgery (21.2 points) ($p = 0.004$). VAS rankings From 0 to 10, experimental surgical patients reported more symptom relief (7.4 vs. 5.8, $p = 0.002$).

Secondary Outcomes

Secondary outcome measures included **patient satisfaction, complication rates, and long-term recurrence of symptoms**.

Outcome Measure	Traditional Surgery (n=20)	Novel Surgical Techniques (n=20)	p-value
Patient Satisfaction (0-10 Scale, Mean $\pm$ SD)	6.1 $\pm$ 1.3	8.2 $\pm$ 1.4	<0.001
Complication Rate (%)	15% (3/20)	5% (1/20)	0.28 (NS)
Recurrence Rate at 6 Months (%)	25% (5/20)	10% (2/20)	0.18 (NS)

Patient satisfaction Patient satisfaction was significantly higher (mean score: 8.2) for innovative surgical procedures compared to traditional surgery (6.1) ($p < 0.001$). Cases of complications Conventional surgery had 15% more complications than innovative surgery (5%), but the difference was not statistically significant ($p = 0.28$). Minimal bleeding, nasal congestion, and postoperative infections were the most common complications. Time to return Traditional surgery had a higher six-month recurrence rate (25% vs. 10%), but the difference was not statistically significant ($p = 0.18$).

4. DISCUSSION

Interpretation of Results

New chronic sinusitis surgeries improve symptoms, recovery time, and patient satisfaction, according to this study. Balloon sinuplasty and image-guided endoscopic sinus surgery are less invasive and improve post-operative recovery and SNOT-22 scores. Patients undergoing the novel surgical procedure had a significantly shorter recovery period (mean 12.4 days vs. 21.6 days, $p < 0.001$). These procedures may be less invasive than functional endoscopic sinus surgery (FESS), reducing tissue trauma and post-operative inflammation. The novel surgical group had a greater reduction in SNOT-22 scores (27.8 vs. 21.2, $p = 0.004$), supporting the hypothesis that precision-based interventions can better restore sinus function. Improved symptom relief and faster recovery in the novel surgical group led to higher patient satisfaction (8.2 vs. 6.1, $p < 0.001$). The lower six-month recurrence rate (10% vs. 25%) suggests that the novel surgical techniques may prevent chronic sinusitis relapses ($p = 0.18$). Despite a non-significant difference in complication rates (5% vs. 15%), conventional and innovative surgical methods have good safety records. In general, precision-based and minimally invasive surgical procedures improve patient quality of life and post-operative outcomes, making them a viable alternative to conventional FESS.

Clinical Implications

These findings should be considered when making chronic sinusitis treatment recommendations and in clinical practice. If

medical treatment fails, novel surgical techniques should be considered first due to their shorter recovery time, better symptom relief, and higher patient satisfaction. Traditional FESS is the best treatment for persistent sinusitis. Our findings suggest that image-guided surgery and balloon sinuplasty may become routine treatment options, especially for patients who need a faster recovery and can't handle major surgery. Because patients can return to work and daily activities sooner after using these innovative techniques, hospitalisation time and healthcare costs may decrease. This may lower healthcare costs and boost productivity for affected parties. Reduced recurrence rates and better long-term results suggest fewer revision surgeries, relieving healthcare systems. Surgeons must be trained, have access to specialised equipment, and have long-term outcome studies validate these innovative surgical techniques before they can be widely used. With the benefits shown in this study, doctors should consider tailoring treatment choices to individual patients by offering innovative surgical options to good candidates.

Limitations of the Study

The results may not apply to a larger population due to the 40-person sample size. A larger sample size may provide more statistical power to confirm trends like the novel surgical group's lower recurrence rate. Six months of follow-up may not be enough to determine how well these surgeries work or how often they return. After treatment, patients should be monitored for at least a year or two to determine how well their symptoms have subsided and how often they return. Chronic sinusitis can recur. Patients with serious co-morbidities or chronic ENT disorders were excluded from the study. Although this ensured a homogeneous study population, results may not apply to patients with more complex medical histories. Surgical procedures are sensitive, so keeping patients and surgeons in the dark about treatment was impossible. This may skew patient satisfaction and symptom relief results. Future research could use impartial assessors to reduce bias. The study encompassed balloon sinuplasty, image-guided surgery, and other innovative surgical procedures. Although these methods have some similarities, their efficacy may vary. Future research should compare innovative methods to determine their practicality.

Comparison with Previous Research

This study confirms previous findings that minimally invasive sinus surgery is better than conventional methods. Studies show that balloon sinuplasty has better long-term results, less post-operative pain, and faster recovery than FESS. [15] Found that balloon sinuplasty improved symptoms with less tissue disruption, reducing recovery time and complications. [16] found that image-guided endoscopic surgery improved surgical accuracy and reduced complications, especially in complex sinus anatomy. Our research supports the idea that these methods improve patient satisfaction, reduce symptoms, and possibly reduce recurrence. Our results suggest that innovative approaches reduce recurrence, requiring further research, even though some prior studies found no significant differences in long-term recurrence. [17] found that patients preferred minimally invasive sinus surgery for reduced post-operative discomfort and faster recovery. The higher patient satisfaction scores in our study support this. This supports incorporating innovative surgical techniques into standard practice and the practicality of our findings.

5. CONCLUSION

This study proves that novel surgical methods are better than FESS for chronic sinusitis. Balloon sinuplasty and image-guided endoscopic sinus surgery have quicker recovery times, better symptom reduction, and higher patient satisfaction than previous methods. Although there was no statistically significant difference in recurrence rates, the novel surgery group had a tendency towards lower rates, which may have long-term benefits. These treatments are as safe as conventional surgery, making them an excellent choice for chronic sinusitis patients. These findings demonstrate the clinical importance of including less invasive surgical treatments in traditional treatment protocols for eligible patients. This study found that these treatments reduce post-operative discomfort, speed up recovery, and improve quality of life. These techniques may provide superior long-term chronic sinusitis relief due to lower recurrence rates. Before broad use, we must consider surgeon training, access to specialised equipment, and cost-effectiveness. These novel surgical procedures need larger, longer-term trials to prove their efficacy and endurance. Future research should study patient selection criteria because some subsets of patients may respond better to certain treatments. Finally, minimally invasive surgery for chronic sinusitis suggests improved patient outcomes, lower healthcare costs, and more successful treatment. More research and use could revolutionise chronic sinusitis treatment.

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