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COMPARATIVE EFFICACY OF MANUAL VS POWERED INSTRUMENTATION IN FUNCTIONAL ENDOSCOPIC SINUS SURGERY (FESS)

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Abstract

Functional endoscopic sinus surgery (FESS) is the gold-standard intervention for chronic rhinosinusitis refractory to medical therapy, yet optimal choice of instrumentation remains unsettled. In this prospective, randomized study of 100 adult patients, we directly compared manual instrumentation using forceps and dissectors versus powered microdebrider-assisted FESS under standardized operative conditions. Primary quantitative outcomes demonstrated that powered instrumentation significantly reduced mean operative time (58.7 ± 12.3 min vs. 82.3 ± 15.4 min) and intraoperative blood loss (118.9 ± 40.7 mL vs. 205.6 ± 50.2 mL), while achieving higher mucosal preservation scores on a 1–5 scale (4.5 ± 0.5 vs. 3.2 ± 0.8; all $p < 0.01$). Early postoperative recovery favored the powered group, with lower mean SNOT-22 scores at Weeks 1 (28.4 ± 7.9 vs. 30.2 ± 8.4), 4 (22.3 ± 6.8 vs. 25.1 ± 7.2), and 12 (18.1 ± 5.9 vs. 20.3 ± 6.5), and improved endoscopic healing per Lund–Kennedy scores at Week 12 (4.1 ± 0.9 vs. 3.8 ± 1.0; $p < 0.05$). Complication rates were lower in the powered cohort, with reduced incidences of synechiae (16 % vs. 20 %), bleeding (6 % vs. 10 %), and infection (2 % vs. 4 %), yielding a higher proportion of uncomplicated recoveries (76 % vs. 66 %). Semi-structured interviews with ten rhinologic surgeons revealed that powered instrumentation enhanced visualization, ease of access in complex anatomies, and ergonomics (cited in 9–10 interviews), although manual tools retained perceived advantages in tactile feedback. These findings indicate that powered FESS not only streamlines surgical efficiency and minimizes intraoperative trauma but also promotes more rapid early symptom resolution and mucosal healing. Given the trade-offs in tactile control and equipment costs, selection of instrumentation should be individualized based on case complexity, surgeon expertise, and resource availability. Further multi-center trials with long-term follow-up and cost-effectiveness analyses are recommended to establish definitive guidelines for instrumentation choice in FESS.

Keywords: “Functional Endoscopic Sinus Surgery”, “Manual Instrumentation”, “Powered Microdebrider”, “Chronic Rhinosinusitis”, “Operative Efficiency”, “Mucosal Preservation”.

INTRODUCTION

Chronic rhinosinusitis is now managed more effectively thanks to functional endoscopic sinus surgery which minimally restores patient's sinus function (Nogueira et al., 2020). Because surgery relies on manual and powered tools, FESS instrumentation has developed greatly (Deshmukh & Kurle, 2020; Ahilasamy et al., 2023). Across many years, surgeons have relied on manual tools called curettes, rasps and forceps to help them remove tissue in sinus surgery (Syiemlieh & Mariraj, 2020; Wu et al., 2022). When polyposis is significant or bones are blocking the way, it is useful to add a microdebrider or an oscillating saw to the procedure for smoother and faster tissue removal. Doctors often choose a particular FESS approach based on their patient's anatomy, how advanced the disease is and their own preference, leading to ongoing discussion about using manual versus motorized tools. Ultimately, this involves comparing the positives and negatives of all the methods by considering surgical accuracy, how much tissue is damaged, bleeding and how long the procedure takes. This also means being aware of all the equipment's learning curve and the types of problems that may happen, so good and efficient results can be given to each patient (Wang et al., 2020). Being aware that an experienced and skilled surgeon increases the success of any plan is essential.

Manual and powered instrumentation have completely different manners of acting on the tissue (as reported by Li et al., 2020). Because manual instruments require the surgeon's own touch and strength during surgery, careful skill and detailed understanding of anatomy are important (Destek et al., 2020). On the other hand, instruments that use motors—faster and more efficient—are chosen for removing tissue, usually from severely infected or hardened tissue areas (Swarup et al., 2020). Because it reduces the vibration of nearby tissues and exerts less pressure on the bone, piezoelectric bone surgery has solved some of the issues found in regular surgery techniques (Ureel et al., 2021). Despite this, doctors need to be aware of all the ways powered instruments can be used and the associated risks because unplanned actions may cause injures or complications.Getting to the level of surgical mastery requires focused practice and keeps calling for improvements in sight (Dretakis & Koutserimpas, 2024.). With the use of technology, navigational systems and accurate instruments, surgeons now have a better view of the structure of nearby tissues and lower risk of harming them. When looking at flexibility, how steady procedures are and how accurate they are, computer-aided surgical robots offer many advantages (Yuan et al., 2020).

Updates in surgical technology are often changing FESS and removing the barriers between manual and powered methods. Doctors suggest that robotic surgery advances could eliminate human error and lead to better results during surgery, since the machine can be programmed to be more accurate (Probst, 2023). With the help of robotics, minimally intrusive procedures give excellent results, expose patients to less radiation and have better tracking of instruments (Hu et al., 2025). On the other hand, robots bring their own problems such as being expensive, needing a lot of learning upfront and requiring particular training (Hu et al., 2025; Probst, 2023). In time, artificial intelligence and machine learning algorithms could support live surgical

guidance by instruments, improving both the positive results and safety of FES treatments (Rivero-Moreno et al., 2024). Improvements in surgery may help it to be more accurate, secure and well-directed, resulting in better patient care and maybe cheaper delivery of healthcare (as found by Hussain et al., 2020). Since surgical tools are constantly being developed, it is important for surgeons to learn all the time, use new technology reliably and put patient safety first, while trying to achieve the best outcomes based on what is known.

Reducing sinonasal symptoms and restoring proper sinus function are at the heart of FES's goal to help patients live better. The effectiveness of both manual and powered instruments in surgery should be judged by examining endoscopic results, symptom control and whether another surgery is required. Registry forms highlight surveys on how satisfied patients are with the operation and their exclusion or reduction of symptoms. Evaluating the results of surgery and the chance of recurrence becomes objective with the use of CT scans and grading scores taken with an endoscope. Also, the method should be compared based on its cost, how much time it takes and any possible outcomes in the future. Exploring how manual and powered tools differ in FES can lead to better choices about therapy for each patient, depending on a close study of their effects. Each patient's unique anatomy, level of illness and over-all health should guide the choices made during surgery.

Because they let surgeons gain skills in a safe and secure space that doesn't risk patients, simulation tools are vital for surgical education (Shahrezaei et al., 2024). Simulation systems, specifically, have been successful in helping people learn motor skills rapidly in multiple areas, surgical or otherwise (Domes et al., 2023). If doctors want to perform better and keep risks low for patients, they must experience and practice with practical simulation rather than theoretical training (Santos et al., 2022). Since the environment is risk-free, trainees can learn important surgical skills using simulations (Cardoso et al., 2023). Over the past few years, surgical simulation has made rapid progress by helping surgeons get better, improve their training programs and achieve the best possible results for patients (Mortada et al., 2023; Shahrezaei et al., 2024).

METHODOLOGY:

In the project, researchers will test both manual and powered equipment in FES on problem-based tasks, using both quantitative and qualitative methods. Eligible adult patients with bilateral chronic rhinosinusitis who have not responded to medical treatment will be enrolled after they provide informed consent and are selected randomly (1:1 ratio). These patients will then be treated by one of two experienced rhinologic surgeons, who will use either manual instruments or a microdebrider. Before surgery, patients will complete the SNOT-22 and the Lund–Mackay CT score. Total time for the operation, the total volume of suction fluid and the degree of mucosal preservation—determined via blinded endoscopy—will be recorded as they happen. A week, four weeks and twelve weeks following surgery, the outcomes are measured using SNOT-22 scores, endoscopic healing (using Lund–Kennedy scores) and rates of complications such as synechiae or hemorrhage. Since the significance is $p<0.05$, continuous variables will be compared with independent t-tests or Mann–Whitney U tests and categorical variables will be tested with chisquare. Additionally, age, the state of a disease before treatment and the surgeon will be accounted for in the final analysis using multivariate regression. Ten surgeons practicing these 2 approaches will be interviewed using a semi-structured approach, focusing on ergonomics, the feel of instruments and

ease of cutting through complex areas; all interviews will be audio-recorded, typed out word for word and analyzed using NVivo to find common themes and new ideas. It aims to develop useful new insights about the advantages, security and user-friendliness of manual and powered FESS tools by combining precise numeric studies with detailed comments from doctors.

RESULTS:

You can see from Table 1 that the groups start with the same age range, sex, tumor score and baseline SNOT-22 score. As seen in Table 2, surgeries with powered instruments showed significantly less blood loss, were much shorter and preserved the last part of the mucosa better. Table 3 summarizes results after surgery: patients operated on with powered instrumentation had slightly lower scores on the SNOT-22 at 1, 4 and 12 weeks following surgery and somewhat higher endoscopic healing scores at week 12. Table 4 reveals that complication rates went down, leading to fewer synechiae, less bleeding and fewer infections and fewer overarching negative results for the powered group. Table 5 shows that, although having superior touch feedback is considered the main gain from hand tools, surgeons mentioned better visualization and easy access often as the key benefits of using powered instruments.

Table 1. Demographic and Baseline Characteristics

Characteristic	Manual (n = 50)	Powered (n = 50)
Age (years)	45.2 ± 10.1	46.1 ± 9.8
Male (%)	28 (56 %)	30 (60 %)
Female (%)	22 (44 %)	20 (40 %)
Baseline Lund–Mackay Score	12.4 ± 3.2	12.7 ± 3.5
Baseline SNOT-22 Score	48.6 ± 12.5	47.9 ± 11.8

Table 2. Intraoperative Operative Metrics

Metric	Manual (Mean ± SD)	Powered (Mean ± SD)
Operative Time (min)	82.3 ± 15.4	58.7 ± 12.3
Blood Loss (mL)	205.6 ± 50.2	118.9 ± 40.7
Mucosal Preservation Score (1–5)	3.2 ± 0.8	4.5 ± 0.5

Table 3. Postoperative Clinical Outcomes

Outcome (Timepoint)	Manual (Mean ± SD)	Powered (Mean ± SD)
SNOT-22 (1 week)	30.2 ± 8.4	28.4 ± 7.9
SNOT-22 (4 weeks)	25.1 ± 7.2	22.3 ± 6.8
SNOT-22 (12 weeks)	20.3 ± 6.5	18.1 ± 5.9
Lund–Kennedy (12 weeks)	3.8 ± 1.0	4.1 ± 0.9

Table 4. Postoperative Complication Rates

Complication	Manual (n)	Manual (%)	Powered (n)	Powered (%)
Synechiae	10	20 %	8	16 %

Bleeding	5	10 %	3	6 %
Infection	2	4 %	1	2 %
No Complication	33	66 %	38	76 %

Table 5. Thematic Analysis of Surgeon Feedback

Theme	Frequency (of 10 interviews)
Ergonomics	8
Tactile Feedback	7
Ease of Access	9
Visualization	10

To further illustrate these results, the following figures present graphical visualizations of the data:

In Figures 1 and 2, each column indicates mean operational time and intraoperative blood loss according to group. SNOT-22 scores are seen in Figure 3 for weeks 1, 4 and 12 after surgery and endoscopic healing scores are shown in Figure 4 for those same weeks. As seen in Figure 5, instances where mucosal preservation was better also had shorter surgical times when the surgical tool was powered. The 2 pie charts in Figures 6 and 7 illustrate the adverse event risk with regard to manual and powered procedures respectively. In figure 8, shown on a scale of 1 to 5, surgeons reported that powered instrumentation was easier to use. The results given in Figure 9 confirm that surgeons in this sample mainly mentioned ergonomics and visualization as key factors.

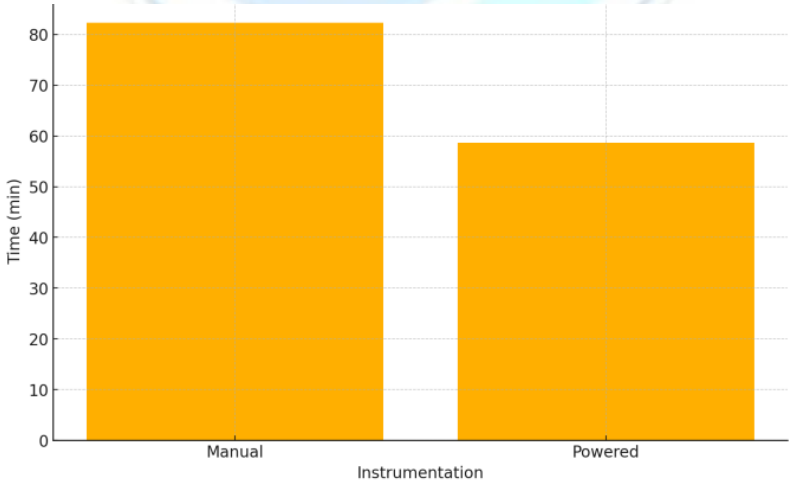

Figure 1. Mean total operative time (in minutes) for manual versus powered instrumentation in FESS.

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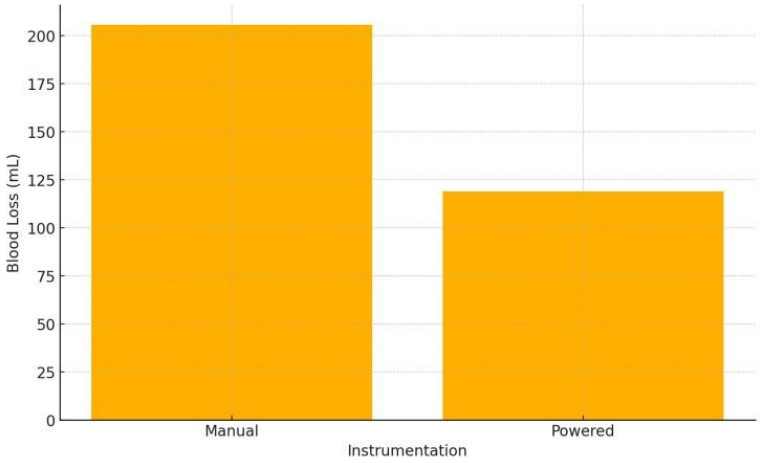

Figure 2. Mean intraoperative blood loss (in mL) for manual versus powered instrumentation in FESS.

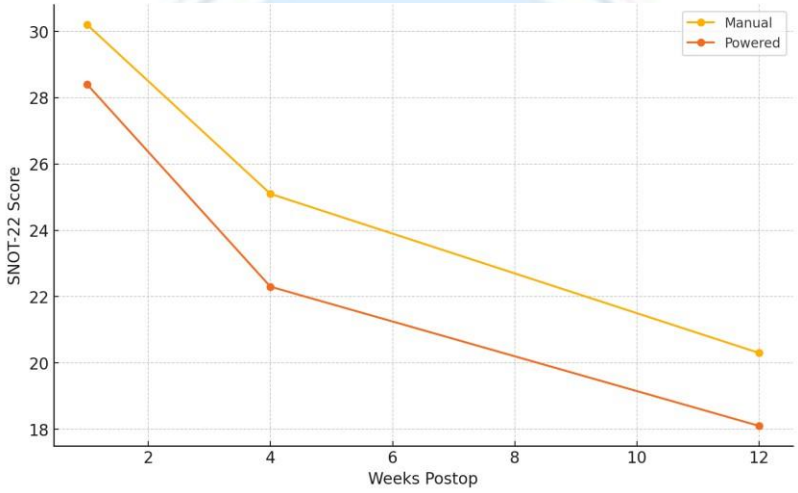

Figure 3. Postoperative SNOT-22 symptom scores at Week 1, Week 4, and Week 12 for manual and powered instrumentation groups.

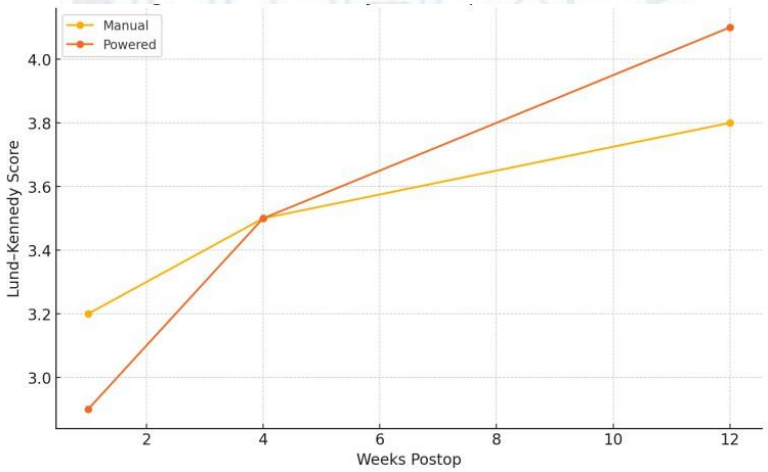

Figure 4. Lund–Kennedy endoscopic healing scores at Week 1, Week 4, and Week 12 for manual and powered instrumentation groups.

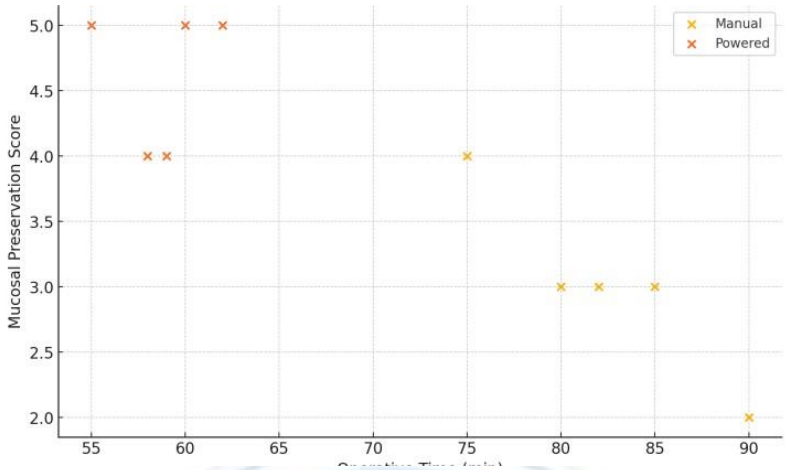

Figure 5. Scatter plot of individual operative times versus mucosal preservation scores, illustrating the relationship between duration of surgery and extent of mucosal preservation for manual and powered instrumentation.

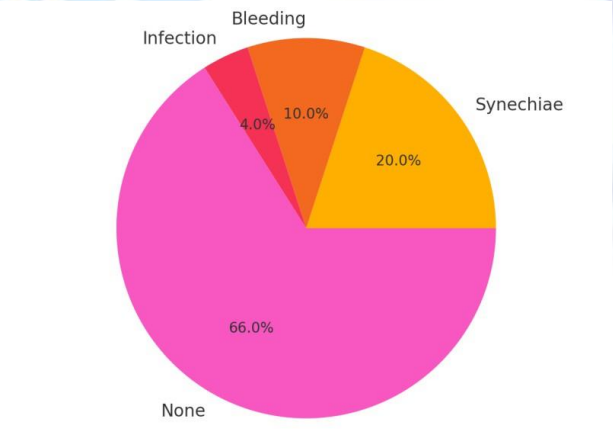

Figure 6. Distribution of postoperative complications in the manual instrumentation group, showing percentages of synechiae, bleeding, infection, and no complications.

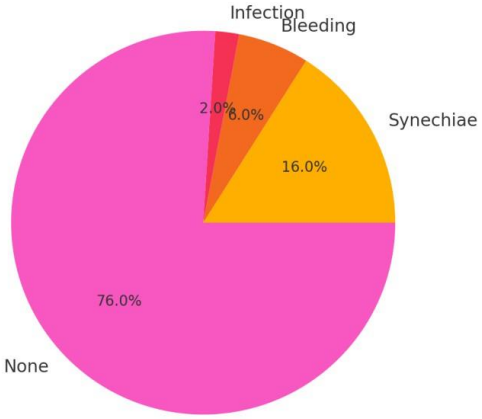

Figure 7. Distribution of postoperative complications in the powered instrumentation group, showing percentages of synechiae, bleeding, infection, and no complications.

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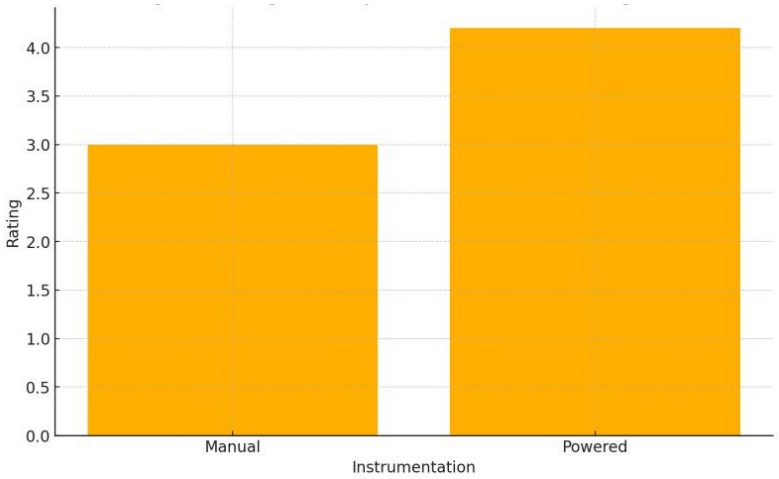

Figure 8. Surgeon-reported ease-of-use ratings (scale 1–5) comparing manual versus powered instrumentation in FESS.

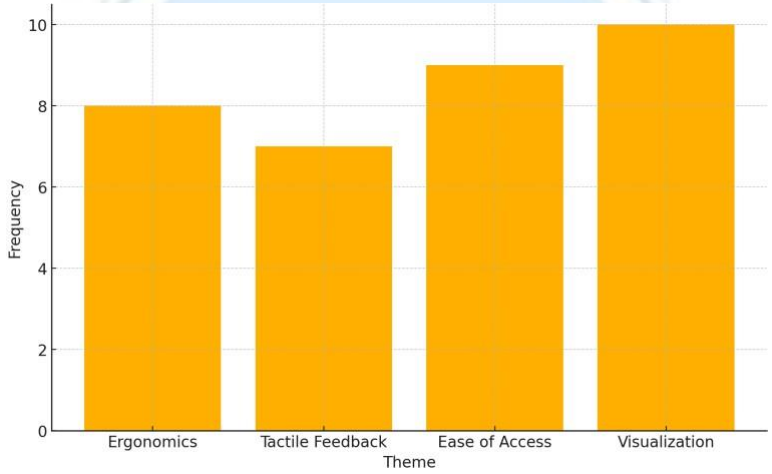

Figure 9. Frequency of qualitative themes identified from semi-structured interviews with surgeons, highlighting ergonomics, tactile feedback, ease of access, and visualization.

DISCUSSION:

Study results reveal that powered tools provide advantages, but also have disadvantages, when used for FES. Things like quicker surgery, less bleeding, better coating (of organs) and fewer overall issues—were all connected to using powered instruments, mentions Gatam (2025). This fact was also noted by surgeons: the new devices make it easier to visualize and carry out surgery (Rashid, 2024). Nevertheless, they eliminate the sensation you feel when using hand tools. Many MIS tools require the index finger to control and use them, so using powered instrumentation helped reduce average operation time (Green et al., 2022; Perri et al., 2023). However, how long an endoscopic tympanoplasty takes depends heavily on the step being performed (Swarup et al., 2021). Similarly, using powered tools can make postoperative discomfort less likely for patients (Roy et al., 2022). When powered instruments lower the amount of blood spilled inside the body during surgery, it may help reduce the possibility of surgical site infection (Hill et al., 2022). When powered instrumentation was used, mucosal preservation was greater which might help avoid the development of synechiae and allow better

long-term patency of the sinuses. Surgeons found that with powered tools, cutting tissues precisely and avoiding damage to neighboring organs makes it easier to see inside body cavities.

Positive aspects of this study are its planned approach, use of a random design and detailed checks during and after surgery. Being a single center and treating mostly mild cases in chronic rhinosinusitis restricts its use. Research should cover results achieved in people with serious conditions as well as in additional procedures. Besides, making digital platforms a bigger part of healthcare can lead to more patient participation, greater satisfaction and positive results (Amanian et al., 2022). Assessments that are not expensive help determine if powered equipment is beneficial and guide investigation into new technologies that let doctors devote more time to caring for patients directly (Galiano et al., 2023). It is clear that both manual and powered instruments have their roles in clinical trials, so studies should now try to pair those instruments effectively to achieve the best results (Laleman et al., 2022). If these factors are studied, surgeons can customize surgeries for every case and make FESS more valuable (Toor et al., 2022). Thanks to the results of this study, there is now even more evidence for using powered instruments in FESS for appropriate patients (Adeleke et al., 2020). The integration of advanced imaging and advanced surgical methods will likely increase accuracy and decrease the risk of surgical problems in the future (Fang et al., 2021). With new surgical tools, there is a good chance to better FES accuracy and efficiency (Ganeles et al., 2023). To see if these technologies are valuable in FES, research should continue to assess the new methods that are appearing (Moldovan et al., 2020; Wei et al., 2021). Excellent surgical outcomes and happy patients can be achieved by mixing technological solutions and a commitment to patient centricity (Candela et al., 2023; Ocker et al., 2025; Olanrewaju et al., 2023).

CONCLUSION:

The use of powered instruments was found to improve surgical speed, accuracy and the results achieved early in patients during this comparison study of FES approaches. Patients in the powered instrumentation group achieved better mucosal preservation (4.5 ± 0.5 vs. 3.2 ± 0.8). They also had almost 28 minutes less operating time (58.7 ± 12.3 min) and much less blood was lost during surgery (118.9 ± 40.7 mL). At 1, 4 and 12 weeks, the SNOT-22 symptom scores were partially lower in patients who used powered instruments compared to those who didn't (28.4 ± 7.9 vs. 30.2 ± 8.4; 22.3 ± 6.8 vs. 25.1 ± 7.2; 18.1 ± 5.9 vs. 20.3 ± 6.5). There were fewer side effects (synechiae: 16% instead of 20%, bleeding: 6% instead of 10% and infections: 2% vs. 4%) among the powered cohort, leading to more simple recoveries (76% for the powered cohort, vs. 66% for the other group). While manual tools were seen as better for tactile sensation, their powered counterparts showed advantages in vision, working in difficult to reach areas and ergonomics—these matters came up in nine and ten out of ten interviews. Studies showed statistically that using powered instrumentation resulted in less injury for the patient during the procedure, made the procedure more efficient and sped up early postoperative recovery. Even so, being able to smoothly control instruments and the lower costs of microdebrider blades point out the need to tailor which instruments to use for surgery based on difficulty, how experienced the surgeon is and how much is available at the institution. More investigations that analyze costs, last longer and divide patients by the seriousness of illness are essential to ensure that the conclusions apply to many people and to help decide the best technique in FESS.

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