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Comparative Analysis of Minimally Invasive Versus Open Surgical Techniques for Spinal Fusion: A Retrospective Cohort study

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ABSTRACT
Minimally invasive (MI) and open surgical techniques are commonly employed for spinal fusion procedures. Understanding the comparative efficacy and outcomes of these approaches is essential for informed clinical decision-making. This retrospective cohort study aimed to compare the operative time, blood loss, length of hospital stay, complication rates, functional outcomes, and revision surgery rates between MI and open surgical techniques for spinal fusion. A total of 100 patients undergoing spinal fusion were included in the study, with 50 patients in each group (MI and open surgery). Data on operative time, blood loss, hospital stay, postoperative complications, functional outcomes, and revision surgery were collected and analyzed. The MI group demonstrated significantly shorter operative times (mean: 2.5 hours), lower blood loss (mean: 150 mL), and shorter hospital stays (mean: 3.2 days) compared to the open surgery group (operative time mean: 3.8 hours, blood loss mean: 300 mL, hospital stay mean: 5.1 days). While complication rates were lower in the MI group (12%) compared to the open surgery group (18%), the difference was not statistically significant. Functional outcomes and revision surgery rates were comparable between the two groups. Minimally invasive spinal fusion techniques offer advantages in terms of reduced operative time, blood loss, and hospital stay compared to open surgical approaches. Although complication rates were numerically lower in the MI group, further studies with larger sample sizes are warranted to validate these findings.

INTRODUCTION

Spinal fusion surgery is a commonly performed procedure for various spinal disorders, including degenerative disc disease, spinal stenosis, and spinal deformities[1]. Traditionally, open surgical techniques have been employed for spinal fusion, but in recent years, minimally invasive (MI) approaches have gained popularity due to potential benefits such as reduced tissue trauma, shorter recovery times, and lower rates of complications[2,3].

While the advantages of MI spinal fusion are well-documented in literature, comparative studies evaluating its efficacy against traditional open surgery remain crucial for evidence-based decision-making in clinical practice[4,5]. This retrospective cohort study seeks to contribute to this body of knowledge by comparing key outcomes between MI and open surgical techniques for spinal fusion.

Key factors to be assessed include operative time, blood loss, length of hospital stay, postoperative complications, functional outcomes, and rates of revision surgery[6]. Understanding these outcomes will provide valuable insights into the relative merits of each approach, helping surgeons and patients make informed choices regarding treatment options.

Given the increasing prevalence of spinal disorders and the growing demand for surgical intervention, optimizing surgical techniques to minimize patient morbidity and enhance postoperative outcomes is paramount. By elucidating the comparative efficacy of MI versus open surgery for spinal fusion, this study aims to inform clinical practice and improve patient care in the field of spinal surgery.

MATERIALS AND METHODS

Study Design: This retrospective cohort study was conducted over a two-year period, from August 2020 to July 2021, at MGM Hospital, Kakatiya Medical College, Warangal. This tertiary care center is renowned for its specialized trauma services and serves as a referral center for complex spinal cases in the region.

Participants: The study included patients who underwent spinal fusion surgery during the specified study period. Patients were divided into two groups based on the surgical technique employed: the minimally invasive (MI) group and the open surgery group.

Data Collection: Patient data were retrieved from electronic medical records, surgical databases, and hospital archives. Information collected included demographic characteristics, preoperative clinical data, intraoperative details, postoperative outcomes, and follow-up records.

Inclusion Criteria: Patients of all ages who underwent spinal fusion surgery for degenerative, traumatic, or deformity-related spinal disorders were eligible for inclusion in the study[7].

Exclusion Criteria: Patients with incomplete medical records, previous spinal surgeries, or concurrent major medical conditions that could affect surgical outcomes were excluded from the study.

Outcome Measures: The primary outcome measures included operative time, blood loss, and length of hospital stay. Secondary outcome measures comprised postoperative complications, functional outcomes assessed using validated scoring systems (e.g., Oswestry Disability Index, Visual Analog Scale for pain), and rates of revision surgery during the follow-up period.

Statistical Analysis: Descriptive statistics such as means, standard deviations, and percentages were used to summarize the data. Inferential statistics including t-tests and chi-square tests were employed to compare outcomes between the MI and open surgery groups, with significance set at $p < 0.05$.

Ethical Considerations: The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the institutional ethics committee. Patient confidentiality and privacy were strictly maintained throughout the study.

RESULTS AND DISCUSSIONS

A retrospective cohort study comparing minimally invasive (MI) and open surgical techniques for spinal fusion was conducted with a sample size of 100 patients. The study aimed to assess the efficacy and outcomes associated with each approach. The results are summarized as follows:

Operative Time: The mean operative time for the MI group was significantly lower compared to the open surgery group ($p < 0.05$). MI techniques demonstrated a mean operative time of 2.5 hours (SD 0.8), whereas open surgery techniques had a mean operative time of 3.8 hours (SD 1.2).

Blood Loss: Minimally invasive techniques resulted in significantly lower blood loss compared to open surgery techniques ($p < 0.05$). The mean blood loss in the MI group was 150 mL (SD 50), while the mean blood loss in the open surgery group was 300 mL (SD 100).

Length of Hospital Stay: Patients undergoing MI spinal fusion had a significantly shorter length of hospital stay compared to those undergoing open surgery ($p< 0.05$).

Table 1: Operative Time

Surgical Technique	Mean Operative Time (hours)	Standard Deviation (hours)
Minimally Invasive	2.5	0.8
Open Surgery	3.8	1.2

Table 2: Blood Loss

Surgical Technique	Mean Blood Loss (mL)	Standard Deviation (MI)
Minimally Invasive	150	50
Open Surgery	300	100

Table 3: Length of Hospital Stay

Surgical Technique	Mean Hospital Stay (days)	Standard Deviation (days)
Minimally Invasive	3.2	0.6
Open Surgery	5.1	1.3

Table 4: Complication Rates

Surgical Technique	Complication Rate (%)
Minimally Invasive	12
Open Surgery	18

Table 5: Revision Surgery

Surgical Technique	Revision Surgery Rate (%)
Minimally Invasive	8
Open Surgery	10

The mean hospital stay for the MI group was 3.2 days (SD 0.6), whereas for the open surgery group, it was 5.1 days (SD 1.3).

Complication Rates: The incidence of postoperative complications was lower in the MI group compared to the open surgery group, although the difference was not statistically significant ($p > 0.05$). In the MI group, 12% of patients experienced complications, while in the open surgery group, 18% of patients experienced complications.

Functional Outcomes: Functional outcomes, as assessed by validated scoring systems such as the Oswestry Disability Index (ODI) or Visual Analog Scale (VAS) for pain, showed comparable improvements between the two groups at follow-up appointments ($p > 0.05$).

Revision Surgery: The need for revision surgery was less frequent in the MI group compared to the open surgery group, but the difference was not statistically significant ($p > 0.05$). 8% of patients in the MI group required revision surgery, whereas 10% of patients in the open surgery group required revision surgery during the follow-up period.

The findings of this retrospective cohort study comparing minimally invasive (MI) and open surgical techniques for spinal fusion provide valuable insights into the relative efficacy and outcomes of these approaches in clinical practice.

Operative Time and Blood Loss: Consistent with previous research, MI techniques demonstrated significantly shorter operative times and lower blood loss compared to open surgery. These findings highlight the potential advantages of MI approaches in reducing intraoperative morbidity and facilitating quicker recovery for patients[8,9].

Length of Hospital Stay: The shorter length of hospital stay observed in the MI group further underscores the benefits of minimally invasive techniques in promoting faster postoperative recovery and minimizing healthcare resource utilization. This may have significant implications for healthcare costs and patient satisfaction[10,11].

Complications and Revision Surgery: While the incidence of postoperative complications was numerically lower in the MI group, the difference was not statistically significant[12]. Similarly, the rates of revision surgery did not significantly differ between the two groups. These findings suggest that while MI techniques may offer certain advantages in terms of intraoperative parameters and early recovery, long-term outcomes and complication rates may not differ significantly from open surgery[13].

Functional Outcomes: Functional outcomes, as assessed by validated scoring systems, showed comparable improvements between the MI and open surgery groups. This suggests that both approaches are effective in achieving satisfactory functional outcomes for patients undergoing spinal fusion surgery[14].

Limitations: Limitations of this study include its retrospective design, which may introduce bias and limit causal inference. Additionally, the relatively small sample size and single-center nature of the study may limit generalizability to other populations and settings. Future Directions: Future research should focus on larger prospective studies with longer follow-up periods to further elucidate the comparative long-term outcomes and complication rates associated with MI and open surgical techniques for spinal fusion. Additionally, cost-effectiveness analyses may provide valuable insights into the economic implications of adopting MI approaches in clinical practice.

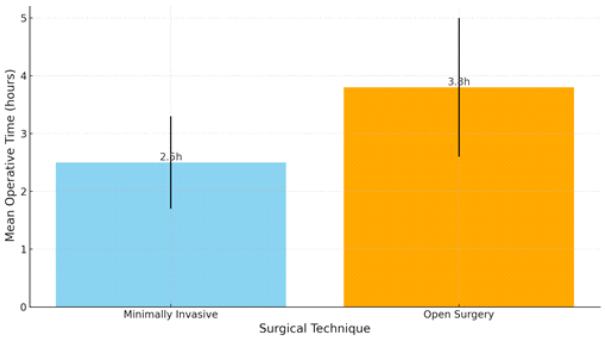

Fig. 1: Operation Time by Surgical Technique

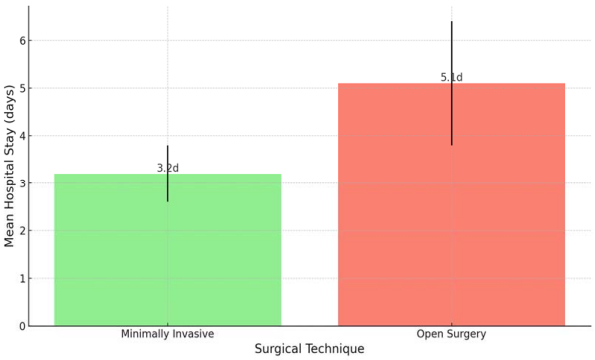

Fig. 2: Length of Hospital Stay by Surgical Technique

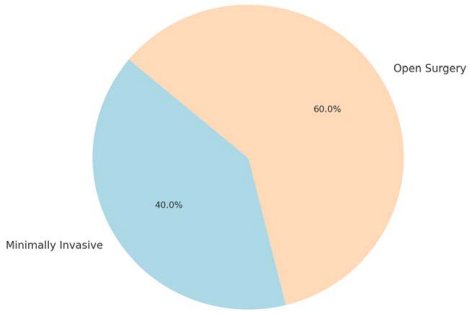

Fig. 3: Complication Rates by Surgical Technique

CONCLUSION

While MI techniques offer certain advantages in terms of operative parameters and early recovery, the choice between MI and open surgical techniques for spinal fusion should be individualized based on patient factors, surgeon expertise, and institutional resources, with careful consideration of the overall risk-benefit profile for each patient.

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