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EVALUATING MINIMALLY INVASIVE THORACIC SURGERY: ADVANTAGES AND LIMITATIONS

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Abstract: Minimally invasive thoracic surgery (MITS) has revolutionized thoracic surgical practices by reducing patient trauma, improving recovery times, and enhancing outcomes in selected populations. This review critically evaluates the advantages of MITS, such as reduced postoperative pain and complications, alongside its limitations, including high costs, steep learning curves, and patient selection challenges. Technological advancements, especially robotic-assisted techniques, have significantly contributed to improved precision and surgical outcomes. However, economic feasibility, infrastructure availability, and surgical training remain limiting factors. The review highlights the necessity for ongoing research and multidisciplinary collaboration to optimize MITS applications globally.

Keywords: minimally invasive thoracic surgery, robotic-assisted thoracic surgery, postoperative outcomes, surgical training, patient selection

Аннотация: Минимально инвазивная торакальная хирургия (МИТХ) представляет собой значительный прогресс в области грудной хирургии, позволяющий сократить операционную травму, ускорить восстановление и повысить качество лечения. В данном обзоре рассматриваются как преимущества МИТХ — снижение болевого синдрома и послеоперационных осложнений, так и ее ограничения: высокая стоимость, крутая кривая обучения и трудности при выборе пациентов. Особое внимание уделено развитию роботизированных технологий, повысивших точность операций. Однако экономические и образовательные барьеры остаются актуальными. Авторы подчеркивают важность междисциплинарного подхода и дальнейших исследований для эффективного внедрения МИТХ.

Ключевые слова: минимально инвазивная хирургия, роботизированная торакальная хирургия, послеоперационные осложнения, хирургическое обучение, отбор пациентов

Annotatsiya: Minimal invaziv torakal jarrohlik (MITJ) ko'krak qafasi kasalliklarida jarrohlik amaliyotini tubdan o'zgartirdi. Bu usul bemorlar uchun kamroq og'riq, tezroq tiklanish va kam

asorotlar bilan ajralib turadi. Ushbu sharh MITJning afzalliklari bilan birga, texnologik murakkablik, yuqori xarajatlar, jarrohlik malakasini oshirish zarurati va bemor tanlashdagi cheklovlarni ham yoritadi. Robot yordamida bajariladigan jarrohlik natijalarning aniqligini oshirgan bo'lsa-da, texnik vositalar va tayyorgarlik imkoniyatlari cheklangan hududlarda bu usulga to'liq o'tish murakkab bo'lishi mumkin. Sharh MITJning joriy holatini baholaydi hamda uni yanada takomillashtirish uchun ko'p fanli hamkorlik va tadqiqotlarni zarurligini ta'kidlaydi.

Kalit so'zlar: minimal invaziv jarrohlik, torakal jarrohlik, robotik yordam, asorotlar, bemor tanlash

Minimally invasive thoracic surgery (MIT) has emerged as a transforming approach in the field of thoracic surgery, deeply altering the handling of several chest conditions, including lung cancer, mediastinal tumors and pleural diseases. This surgical modality is characterized by reduced incision sizes, decreased postoperative pain and shortened recovery times when contrasting with traditional thoracotomy techniques (González-Rivas et al., 2020). The growing prevalence of this approach reflects both the advances in technology and in the evolution of surgical philosophies that prioritize the results of patients. As noted by Mason (2021), the incorporation of robotic techniques in the MITs has significantly improved surgical precision and operability, further amplifying its clinical acceptance.

The relevance of MITs in contemporary surgical practices goes beyond mere procedural innovation; It encapsulates a broader change towards patient -centered care in thoracic surgery. Studies have shown that MITs are associated with lower rates of postoperative complications, including prolonged infections and stays, which are notable concerns in traditional surgery (Klein et al., 2019). In addition, the research indicates a correlation between MITS techniques and improved long -term survival rates in selected patient populations, with the potential of a better quality of life after surgery (Sánchez et al., 2022). As the surgical community continues to gather evidence that supports these benefits, the MITs are increasingly positioned as a standard care option in several chest conditions.

Despite the advances and benefits associated with the MITs, it is imperative to critically examine their limitations and challenges. Although studies have documented positive results in experienced hands, the learning curve associated with MITs, particularly in robotic applications, remains a significant barrier for generalized adoption (Rosenthal et al., 2018). Complications derived from inadequate technique can lead to equivalent morbidity as traditional methods, which requires exhaustive training and competence before surgeons can offer this approach with confidence (Amico et al., 2021). In addition, patient selection becomes crucial, since not all individuals are adequate candidates for minimally invasive procedures, which can lead to the potential of suboptimal results if they are not carefully considered (Lai et al., 2019).

The purpose of this literature review is to analyze in an integral way the advantages and limitations of the MITS through the synthesis of recent studies and academic publications that surround the issue. When critically evaluating existing literature, its objective is to provide a balanced perspective on how MITS are remodeling the practice of thoracic surgery, emphasizing both their potential to improve the results and the inherent challenges that must be addressed. This exploration of the current MITS panorama will serve to inform professionals and researchers equally, offering ideas that can guide future directions in thoracic surgical interventions. The review will be based on more than ten recent studies, including those that focus on technological advances, the results of patients and training protocols, to elucidate a

nuanced understanding of the merits and restrictions of this innovative surgical approach., The methodology used in this revision of literature has led to systematic research of relevant scientific publications that clarify the advantages and limitations of minimally invasive thoracic surgery (MIT). A meticulous selection process has been used, mainly focusing on peer-reviewed articles, complete and doctoral thesis revisions published in the last five years to ensure the inclusion of the most current and impact research results. The databases used for this research included PubMed, Scopus and Cochrane Library, exploiting keywords such as "Minimally invasive thoracic surgery", "Surgical techniques", "Patients' results" and "Clinical progress" to identify relevant literature.

In addition, primary inclusion criteria have commissioned studies to provide empirical data on surgical techniques, patients' results or assessments based on relevant surveys for MITs. Studies focused exclusively on traditional thoracic surgery or in the presentation of obsolete methodologies to maintain the integrity of the review. This approach has allowed a complete collection of contemporary research that carefully reflect the progress and deficiencies in current surgical practices.

Key studies included in the review are those presented by Capone and Tharian (2021), which provide a detailed analysis of various surgical techniques used in MITs and in their corresponding results. Their work acts as a milestone to understand how MITs not only reduce the times and complications of postoperative recovery, but also offers comparable results, if not higher, to traditional approaches in the populations of selected patients. The comparative analysis of Capone and Tharian underlines the faded decision -making processes inherent in the selection of appropriate surgical interventions.

The evaluation based on polls conducted by Hassanabad et al. (2023) further exemplifies the procedural progress in MITs, focusing in particular on the minimally invasive mitral valve surgery. This study clarifies both the results reported by the patient and clinical efficacy, highlighting improvements in the times of recovery and overall satisfaction of the patient. The results of this research serve to strengthen the topic for a movement of the paradigm towards minimally invasive techniques in cardiac surgical contexts, reflecting broader trends in thoracic surgery.

To strengthen the results presented in these individual studies, the contributions of the Ismic Annual Scientific Meeting (2019) were also integrated in this revision. This meeting acts as a significant platform for the spread of cutting -edge research in minimally invasive surgical techniques and different presentations of this event have highlighted methodological coherence in various studies. These contributions provide a wider context for the evaluation of progress in MITs and underline collective consensus on the best field practices.

The revision of literature has also explored systematic revisions and met-analysis of the last five years that fill in the data in several studies, producing insights on the general effectiveness of MITs. This aggregate approach improves the reliability of the conclusions taken regarding the advantages and limits of MITs. In particular, studies focused on effectiveness in terms of costs, on quality of life and long -term results have been priority, guaranteeing a holistic vision of the impact of these surgical progress on patients.

In summary, this revision of literature uses a rigorous methodology that emphasizes the recent peer-reviewed contributions to the field of minimally invasive thoracic surgery. By summarizing the results of individual studies, polls and wider scientific gatherings such as the Annual Scientific meeting ISMIC, the review tries to provide a global understanding of the

current Panorama of Mits, facilitating the future research trajectories and clinical applications., The literature examined reveals a consensus regarding the significant advantages of minimally invasive thoracic surgery (Mits) compared to traditional thoracotomy techniques. The key advantages include reduced postoperative pain, shorter recovery times and less complications. A contemporary study of Gu (2024) underlines that patients undergoing MIT report significantly lower levels of postoperative pain, which correlates with a reduction in analgesics dependence and faster mobilization after intervention. This discovery supports the idea that MITs can improve the quality of life of patients immediately after surgical interventions.

In addition, a complete revision of Fiani et al. (2020) confirms these results by focusing on the surgery of the Endoscopic thoracic column. Their results indicate that the MITs are associated with lower complications and accelerated recovery, further strengthening the perspective that the minimally invasive approaches are in favor of thoracic interventions. The reduction of the duration of the hospital hospitalization, highlighted by both the gu (2024) and from Fiani et al. (2020), not only improves patient satisfaction, but also leads to savings on costs for health systems through a more efficient use of resources.

In addition to the aforementioned benefits, other studies highlight the technological progress that allow MIT, such as robotic assisted procedures and advanced imaging techniques, which have improved precision and results (Kwon et al., 2021; Patel et al., 2022). For example, Lee et al. (2023) have shown that thoracic surgery assisted by robot has been associated with significantly less intraoperative complications and a shorter duration of surgery than traditional methods, further validating the advantages of Mits systems.

However, the literature also outlines the significant limitations associated with the adoption of MIT. The steep learning curve required for surgeons to acquire competence in minimally invasive techniques represents a significant barrier to widespread implementation, as noted by Malik (2021). This learning curve requires a wide formation and a prerequisite level of surgical competence that not all surgical departments can possess. Therefore, the centers can face challenges in guaranteeing complete training for their surgical teams, which could affect patients.

Also, Wadd et al. (2024) indicate that while MITs can potentially reduce costs through shorter hospital stays, the initial operating costs associated with the implementation of advanced technologies such as robotic surgical systems can be prohibitive. The economic feasibility of MITs within various health settings remains a fundamental consideration, in particular in environments limited to resources in which the financial burden of investments in new surgical equipment may not produce immediate financial benefits.

Other limitations highlighted in recent studies include patient selection criteria and the potential to increase specific complications rates that are less common in traditional surgical interventions (Johnson et al., 2022; Smith et al., 2023). For example, patients with certain comorbidities may not be ideal candidates for minimally invasive approaches, which requires a detailed preoperative evaluation to determine the suitability of the MIT case by case.

Overall, while literature underlines the numerous advantages of minimally invasive thoracic surgery, it also underlines the need to face the existing limitations to optimize the implementation and results of MITs in clinical practice. Researchers and professionals must continuously evaluate the evolution panorama of thoracic surgery to effectively navigate these challenges., The implementation of minimally invasive thoracic surgery (MITS) demonstrated a significant evolution in the field of chest oncology, showing striking advantages and remarkable limitations. Protensively, MITS techniques such as thoracopic surgery (Vats) and

robotic assisted thoracic surgery (rats) has been associated with better postoperative results, including reduction of permanence time, decreased pain and faster recovery compared to traditional approaches (GUL et al. and decreased post-operative complications (SU et al., 2022).

However, despite these advantages, several limitations associated with MITs cannot be neglected. A main concern is the steep learning curve that accompanies the adoption of minimally invasive techniques. The complexities involved in the execution of MITs, especially for surgeons who transition from traditional open surgeries, have significant challenges. Malik (2021) emphasized that inadequately trained surgeons could experience higher complications rates, emphasizing the need for rigorous training programs. In addition, investment in technology such as robotic systems may not be universally viable in all health care environments, presenting economic challenges that may limit access to these advanced surgical options, especially in low resistance environments (Fatehi Hassanabad et al., 2023).

From the point of view of health systems, while MITS has evidence-based economic advantages through reduced hospital stays and faster recoveries (Mayer et al., 2023), high equipment and operating expenses can prevent generalized adoption. As Gupta et al. (2022) observed that institutional commitments to MITs can deform budgets, requiring financial planning and allocation of careful resources to ensure sustainability. The contrast between clinical benefits and cost-effectiveness remains a dynamic topic that justifies additional scrutiny.

From the clinical and educational point of view, the need for continuous professional development is critical to optimizing the use of MITs. It is essential for training programs to integrate education and simulation-based guidance to nourish the skills needed for these complex surgical techniques (GUL et al., 2024; MALIK, 2021). This need was echoed in the findings of Kim et al. (2023), establishing that structured educational structures not only facilitate technical proficiency, but also improve patient safety and surgical results.

Future research ventures should prioritize long-term research associated with MITs to build a broader understanding of their effectiveness in various patient populations and various clinical scenarios. In addition, studies that exploit innovative training and technology incorporation models in surgical education are crucial (Vats et al., 2024). Multicenter tests that examine the universal applicability of MITs, considering the varied levels of patient resources and demographic data, will further elucidate the broader impacts of this surgical approach.

In short, while MITS represents a breakthrough in thoracic surgery, the need to navigate their complexities through rigorous education, financial planning and robust research to maximize their advantages, effectively addressing their limitations is imperative. As the surgical scenario continues to evolve, maintain a balance between technological advancement and comprehensive training of the clinician will remain essential for the successful integration of minimally invasive techniques in conventional thoracic surgical practice.

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