Editorial

From scalpel to robot: the evolving landscape of diaphragmatic plication

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Diaphragmatic plication, a surgical procedure that involves tightening and lowering the weakened hemidiaphragm, has long been a cornerstone in managing unilateral diaphragmatic dysfunction. The significance of this seemingly straightforward procedure is underscored by its pivotal role in treating conditions such as diaphragmatic eventration and paralysis. These conditions can markedly impair pulmonary function, limit daily activities, and even negatively impact survival. As such, diaphragmatic plication carries profound implications not only for the respiratory function but also for the quality of life and overall health outcomes of patients with diaphragmatic dysfunction.

Substantial advances in surgical practice, underpinned by a deeper understanding of diaphragmatic physiology and pathology, have catalyzed significant improvements in the management of patients with diaphragmatic eventration or paralysis. Yet, these advancements also lead to new challenges and controversies, ranging from the adoption of novel technologies to the equitable distribution of healthcare resources. Amidst this dynamic landscape, the recent review by Gilbert and Wei (1) serves as a guiding light, illuminating the current state of the field. The authors offer a comprehensive overview of the surgical management of diaphragmatic dysfunction, encompassing everything from diagnostic evaluation and patient selection to the various surgical approaches used in diaphragmatic plication and their effectiveness. Crucially, the article also delves into the existing controversies and areas ripe for further research, offering a balanced and insightful perspective on the field.

In their review, Gilbert and Wei (1) present a rich array of surgical approaches for diaphragmatic plication, each with its unique benefits and challenges. Regardless of the surgical method employed, the effectiveness of diaphragmatic plication has been well-established. The authors bolster this claim with references to numerous studies demonstrating significant reductions in dyspnea and improvements in pulmonary function. However, the transition from traditional open surgery to minimally invasive techniques, which arguably require higher surgical skills, has been a testament to the relentless pursuit of improved patient outcomes. These less invasive methods have conferred reduced postoperative pain and faster recovery times. This evolution in practice reached a significant milestone with the recent advent of robot-assisted diaphragmatic plication. The promise of enhanced precision and dexterity with robotic systems is tantalizing, yet it is counterbalanced by the reality of increased costs. This raises pivotal questions about balancing surgical innovation and cost-effectiveness, a theme that resonates

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throughout the broader field of healthcare. The authors also candidly share their experiences, detailing their preferred technique of robot-assisted transthoracic diaphragmatic plication. This practical insight, enriched with tips for successful outcomes, serves as a valuable guide for surgeons navigating the complexities of robot-assisted thoracic surgery.

The evolution of diaphragmatic plication has been nothing short of fascinating. Since its inception as a surgical remedy for diaphragmatic eventration a century ago (2), the field has seen a plethora of surgical techniques come to light, spanning from open procedures to minimally invasive transthoracic and transabdominal approaches. Recent years have witnessed a surge in studies comparing the safety and effectiveness of these diverse surgical techniques (3-5). However, it is worth noting that a significant portion of this research comprises retrospective studies with limited patient cohorts. As a result, no single intervention has emerged as definitively superior, highlighting the need for larger, prospective trials to furnish more robust evidence. Nonetheless, the fundamental principles of diaphragmatic plication remain unchanged. Appropriate patient selection and a safely performed, tight plication are the foundations of successful results. As we persist in our quest to innovate, these principles should guide our practice, ensuring our unwavering commitment to patient safety and outcomes.

Innovation serves as the lifeblood of medical advancement, and diaphragmatic plication is no exception. Unquestionably, the most transformative innovations reshaping the wider field of thoracic surgery include the various minimally invasive surgical approaches. These innovations herald new opportunities but also pose challenges. A case in point is the advent of robot-assisted thoracic surgery, a game-changer in diaphragmatic plication. Indeed, the tremor suppression and enhanced instrument control offered by robotic systems prove particularly beneficial for the delicate and intricate maneuvers required during endoscopic suturing, an essential component of diaphragmatic plication. However, the considerable cost of robotic systems and the necessity for specialized training spark important questions about their accessibility. High-cost interventions, such as robot-assisted surgery, may be beyond the reach of many healthcare systems, particularly in low- and middle-income countries. This could potentially give rise to a two-tiered system, where only patients in well-resourced settings have access to the latest surgical innovations. As we embrace cutting-edge technological advancements, we must also grapple with their accompanying financial challenges to ensure that the benefits of innovation are accessible to all patients.

In the pursuit of surgical excellence and innovation, it is crucial that we do not lose sight of the ultimate goal of any surgical intervention: to improve patient outcomes and quality of life. In this vein, Gilbert and Wei (1) emphasize the importance of patient-centered outcomes, such as self-reported dyspnea, in gauging the success of diaphragmatic plication. This is a timely reminder of the significance of integrating the patient's perspective into our evaluation of surgical success. As we continue to refine our surgical techniques, we must also strive to better understand and measure the impact of these interventions on patients' lives. A recent development in this area is a questionnaire specifically designed to assess the quality of life of patients with diaphragmatic paralysis, providing a tool to evaluate the effects of surgery in terms of patient-relevant outcomes (6). Further validation of this questionnaire, along with the creation of additional patient-reported outcome measures specifically designed for patients undergoing diaphragmatic plication, is an important next step.

Surgical practice, including diaphragmatic plication, is not an isolated entity. It is molded by a multitude of factors extending beyond the confines of the operating room, from healthcare policy to social considerations. Healthcare policies, particularly those regarding reimbursement, can significantly influence the adoption of new technologies. For instance, a novel technique that offers superior effectiveness but also incurs higher costs due to equipment and training may not gain widespread acceptance if it lacks adequate reimbursement. Social factors, such as evolving patient expectations and the growing emphasis on patient-centered care, also come into play. As patients become increasingly informed and engaged in their care, there may be heightened demand for minimally invasive techniques that promise shorter recovery and less discomfort. In this complex landscape, it is imperative for healthcare professionals and policymakers to work collaboratively in optimizing surgical practices, ensuring that innovations in diaphragmatic plication are both clinically effective and accessible.

Diaphragmatic plication is poised at an exciting frontier, with the promise of advancements and the challenge of new questions. As we steer through this evolving field, our compass must be guided by the principles of cost-effectiveness, accessibility, and equity. The future of diaphragmatic plication is not just about embracing new technologies, but also about ensuring these advancements

improve the lives of our patients. As we stand on the threshold of these developments, we look forward with anticipation to the advancements on the horizon, ready to tackle any challenges they may bring.

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