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Editorial

Surgical Evolution in the Modern Era: From Quantity to Quality of Life to Surgical Innovation. The Paradigm of Esophageal Cancer Surgery

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INTRODUCTION

From the dawn of modern medicine until today, surgical practice has changed radically. A systematic and multidisciplinary approach of arising innovations has enabled the optimization of surgical practices. Design and implementation of clinical trials has expanded the possibilities of modern surgery, while carefully conducted peer review and meta-analyses has consolidated new knowledge and incorporated it into surgical practice. International and multidisciplinary medical societies have organized these surgical advances, by issuing guidelines and submitting recommendations, aiming to enhance the results of surgical intervention.

But since collectively orchestrated efforts to optimize surgical results have succeeded in many directions, the very target of these efforts has evolved. The initial aim of surgical practice was to increase the survival rate of certain operations and the life expectancy of surgical patients, factors which can be measured quantitatively. After impressive progress was achieved on this axis, surgical advances shifted their focus towards the improved life quality of the surgical patient. In the last two decades, bearing in mind these two fundamental goals, scientists have also worked towards the application of novel technologies into the surgical technique, in an effort to expand the possibilities surgery has to offer in medicine. Therefore, since mid-90's, we became witnesses of a radical surgical evolution: from quantity, to quality-of-life (QoL), to innovation.

Throughout the 20th century, many medical conditions which were considered untreatable have been managed on a large extent, due to the facilitation and subsequent optimization of novel surgical procedures. The initial focus of surgeons was to improve, through their interventions, the quantitative measures of patients' survival. One of the most challenging surgical conditions throughout the years, up until today, has been esophageal cancer. The first transthoracic approach to esophageal resection was performed in 1913 by Franz Torek and since then, multiple advances have been achieved in the field. Ivor Lewis presented in 1946 the two-stage esophagectomy, consisting of laparotomy and right thoracotomy, which is considered the gold standard operation in most centers today. More approaches have been proposed, including the transhiatal oesophagectomy by Turner in 1933 and by Orringer in 1978, as well as the three-stage laparotomy/thoracotomy/cervical incision esophagectomy by McKeown in 1976.[1] This ongoing effort to optimize the surgical approach to a certain condition, has been translated to an increased survival rate and better prognosis of the affected patients.

With the utilization of novel therapeutic modalities, surgical practice has offered patients not only a longer survival period, but also an enhanced post-operative QoL. One of the most impactful revolutions in modern surgery is undoubtedly the advance of laparoscopy and minimally invasive surgery. Although the idea of laparoscopy has been developed since the early 20th century, with the first laparoscopy on humans described by Jacobeaus in 1913, it was up until 1987 that Mouret performed the first laparoscopic cholecystectomy and paved the path for minimally invasive operations.[2] Compared to open surgery, laparoscopic procedures offered the possibility of an enhanced QoL, including minimized post-operative pain, earlier mobilization, shorter recovery period and better aesthetic results.

In the field of esophageal resection, minimally invasive techniques were first introduced in 1992, when Cuschiery reported the first thoracoscopic esophagectomy, that have been integrated in surgical practice since 1996, when Luketich developed the min-

imally invasive esophagectomy (MIE), consisting of a combined thoracoscopic and laparoscopic approach.[3] Throughout the following years, MIE (including hybrid esophagectomy) has gained popularity, due to the improved outcomes, including patients' QoL. As strongly supported by the TIME randomized controlled trial, patients that underwent a MIE were met by more favourable short-term results in post-operative period (6-weeks), including lower incidence of pulmonary infections, shorter hospital stay, and higher scores in QoL questionnaires.[4] Additionally, longer-term QoL (1-year) was also improved, as supported by the questionnaires' score difference. At the same time, quantitative measures regarding mortality, oncologic outcomes and survival rates showed no significant difference between MIE and open esophagectomy in 6-months, 1- and 3-years comparisons.[4-6]

Therefore, the evolution of esophagectomy poses a great example of the surgical transformation that is observed since the end of the 20th century: once the efforts of the surgical community achieved an adequate management of challenging medical conditions and once the quantitative measures reflecting this management reached a plateau, the scientific target shifted, in order to include the improvement of life quality concerning the surviving patients.

As technological advancements arose in the field of biomedical engineering, the surgical community began utilizing emerging innovations, aiming to optimize surgical procedures. The most influential breakthrough in the last two decades was the introduction of robotic assisted minimal invasive surgery. Although the idea of robot-mediated operations has begun since the 1980s and gave birth to several attempts, including Robodoc Surgical System in 1992 and automatic endoscopic system for optimal positioning (AESOP) in 1994, robotic assistance as we know it today, was facilitated with the introduction of daVinci Surgical System in 1998 by Intuitive Surgical. The benefit daVinci offered in the surgical practice included improved ergonomics for the surgeon, with greater precision, easier instrument control, increased range of motion and better visualization of the surgical field.[7] Novel technologies are constantly being tested and integrated, as for example three-dimensional imaging and single port platform, which has been successfully utilized in urologic operations. Moreover, due to the recent expiration of several intuitive surgical patents, multiple manufacturing companies have recently contributed in the evolution of robotic-assisted surgery, thus creating a competitive field and pushing forward the technological progress in favour of surgical transformation. Promising future prospects aim to incorporate devices that allow haptic feedback from the tissues to the operator, regarding force, torque and resistance.[8] The development of systems allowing the integration of radiologic images to the visual image, as well as artificial intelligence systems assisting the surgeon in recognizing structures and performing surgical steps, are already appearing revolutionary.

Regarding upper gastrointestinal operations and especially esophagectomies, the robotic-assisted option was introduced in 2002 by Melvin et al,[9] and in the following years robotic assisted minimally invasive esophagectomy (RAMIE) has been successfully performed in many centers around the world. In two recent meta-analyses comparing open esophagectomy with MIE and RAMIE, in regards to survival rates, oncologic outcomes as well as short- and long-term QoL, the results were more favourable for MIE and RAMIE compared to open, while RAMIE compared to MIE showed mostly similar results, with some trials suggesting RAMIE's superiority in selected factors.[10,11] However, results from randomized control trials advocating or questioning RAMIE's superiority as opposed to MIE, remain to be disclosed. It is therefore possible, that current evolution in the domain of esophageal surgery is gradually shifting from the achievement of quantity and QoL, to the technological innovation.

The surgical transformation manifested through the example of esophagectomy evolution, may suggest that the integration of novel technologies in surgical practice has become a major focus in modern medicine. Until today, the most important aspect of this progress has been the facilitation of surgical procedures, which posed a great technical difficulty. Laparoscopic and especially thoracoscopic operations remain technically challenging, due to the restricted range of motion and the positioning of the instrumental fulcrum on the cavity wall. A challenging step in MIE is the creation of the intrathoracic esophagogastric anastomosis, a procedure which is facilitated by the robotic assistance. The positioning of fulcrum inside the thoracic cavity, in combination with Endowrist, which allows the simulation of wrist movements, offers the surgeon an ergonomic advantage.[12] A possible reflection of this advantage on the incidence of post-operative anastomotic leaks in MIE *vs* RAMIE has not been reported in meta-analyses, and remains to be examined in randomized control trials. Moreover, what needs to be taken into consideration in current comparison between MIE and RAMIE, is the learning curve required, which can affect the outcomes of each operation, in regard to survival and QoL.[13]

Given the example of esophageal resection, one may examine the evolution of surgery throughout the years and reach an observation probably prevailing in many surgical fields: the progress of surgical practice has shifted its focus from the enhanced survival, to the improved QoL and then to the technological facilitation. However, with the achievement of every single goal, the previous one in not deemed unimportant. Survival of patients is adequately ensured, before surgeons channel their efforts to improve QoL. Again, once higher quantitative and qualitative factors are established in a sufficient extent, technological innovations are tested and introduced, in order to optimize surgical practice. In conclusion, the improvement of quantity, quality and technology in surgery may consist of three separate goals, but these goals seem interdependent, and the results of these efforts have been mutually amplified.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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