

ROBOTIC SURGERY IN CONGENITAL DIAPHRAGMATIC HERNIA CORRECTION: A SYSTEMATIC REVIEW

Juliano Massini Medici da Costa

Centro Universitário do Espírito Santo
(UNESC)
Colatina-ES
<https://orcid.org/0000-0002-0701-1138>

Igor Daniel Scarpatti Rosalem

Centro Universitário Multivix Vitória
(MULTIVIX)
Vitória - ES
<http://lattes.cnpq.br/8931665398861595>

Matheus Guio Ferreira Silva

Centro Universitário do Espírito Santo
(UNESC)
Colatina - ES
<http://lattes.cnpq.br/4339466569826166>

Karluanna Cutini Faé

Centro Universitário do Espírito Santo
(UNESC)
Colatina - ES
<http://lattes.cnpq.br/0875545389965343>

Matheus Garcia Carrera

Faculdade de Minas (FAMINAS)
Muriaé - MG
<https://orcid.org/0009-0003-2153-5442>

Vitória Borborema Reis Pereira

Faculdade de Minas (FAMINAS)
Cidade – Estado: Muriaé - MG
<https://orcid.org/0009-0007-4764-0194>

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Vitor César Neves Castro

Centro Universitário de Caratinga (UNEC)
Caratinga - MG
<http://lattes.cnpq.br/1347407661927984>

Franciel Bertoldi

Centro Universitário do Espírito Santo
(UNESC)
Colatina - ES
<http://lattes.cnpq.br/5468567247704740>

Amanda Sfalsin Alencar

Centro Universitário do Espírito Santo
(UNESC)
Colatina - ES
<http://lattes.cnpq.br/7608691834683634>

Ana Clara Gonçalves Luz

Centro Universitário do Espírito Santo
(UNESC)
Colatina - ES
<http://lattes.cnpq.br/1289984432356954>

Etoze Guerra Pedroni

Escola Superior de Ciências da Santa Casa de
Misericórdia de Vitória (EMESCAM)
Vitória - ES
<http://lattes.cnpq.br/6340831584805159>

Deverson Radaeli Maestri

Centro Universitário do Espírito Santo
(UNESC)
Colatina - ES
<https://lattes.cnpq.br/1729226076369970>

Abstract: INTRODUCTION: Congenital diaphragmatic hernia (CDH) is a rare congenital malformation that can lead to serious consequences for neonatal health. Surgery is the standard treatment for CDH, and robotic surgery is being used more and more. However, the effectiveness and safety of robotic surgery compared to other surgical techniques for CDH are still uncertain. **GOAL:** This integrative review aimed to assess the available evidence on the efficacy and safety of robotic surgery for CDH. **METHODOLOGY:** PubMed and embase databases were searched until January 2023, resulting in ten relevant studies. Most studies compared robotic surgery with laparoscopic or open surgery. **RESULT:** The analysis of the results indicated that robotic surgery can be a safe and effective option for CDH, with shorter hospital stay, lower rate of conversion to open surgery and low complication rates. However, there were no significant differences regarding surgical time and surgical complications compared to other surgical techniques. **FINAL CONSIDERATIONS:** While the results are encouraging, more research is needed to confirm the efficacy and safety of robotic surgery for CDH in different patient groups. **Keywords:** Congenital diaphragmatic hernia; Robotic surgery; Laparoscopic surgery.

INTRODUCTION

Congenital diaphragmatic hernia (CDH) is a rare anomaly that occurs in approximately 1 to 5 out of every 10,000 live births, accounting for approximately 8% to 10% of congenital malformations of the gastrointestinal tract (Bhatnagar et al., 2017). CDH is characterized by failure in the development of the diaphragm during pregnancy, resulting in a communication between the thorax and the abdomen and consequent migration of abdominal organs to the thoracic space. This migration can lead to pulmonary hypoplasia,

pulmonary hypertension and respiratory failure, and can be fatal in severe cases (Sathya et al., 2021).

Diagnosis is usually performed by means of fetal ultrasound, however, in some cases, it can only be identified after birth. Early detection of CDH is essential for defining the therapeutic strategy and planning childbirth (Macedo et al., 2018). According to some studies, ultrasonography may present limitations for the accurate diagnosis of CDH, especially in cases of smaller lesions and when there is herniation of organs that are not usually found in the thorax. In this sense, fetal magnetic resonance imaging has been considered a useful tool to complement the diagnosis of CDH and to assess fetal lung morphology and function (Macedo et al., 2018; Dingemann et al., 2017).

The treatment of CDH consists of surgical correction, which can be performed using different techniques, including laparoscopic, thoracoscopic and conventional open surgery. The choice of surgical technique depends on the type and severity of CDH, in addition to the experience of the surgeon and the medical team (Elkholy et al., 2020). Minimally invasive techniques, such as laparoscopy and thoracoscopy, have been associated with less postoperative pain, shorter hospital stays and better cosmetic results compared to conventional open surgery (Weber et al., 2019). However, the minimally invasive approach may present technical challenges in more complex cases of CDH, especially in newborns and infants (Bhamidipati et al., 2020).

With the advancement of surgical techniques, robotic surgery has been used in some institutions as an alternative for the treatment of CDH, with promising results. Robotic surgery allows for greater precision and control of the movements of the surgical instrument, as well as better visualization of

the operative area, compared to conventional surgical techniques (Migliore et al., 2021). In addition, robotic surgery can be performed through small incisions, reducing the length of hospital stay and minimizing postoperative complications (Ponsky et al., 2020).

In this context, the objective of the present study consists of a critical analysis of the current scientific literature on the use of robotic surgery in the correction of congenital diaphragmatic hernia, in order to evaluate the effectiveness, safety and comparability with other surgical techniques.

METHODOLOGY

This is an integrative literature review developed in five stages: 1. Preparation of the guiding question; 2. Literature search; 3. Data collection; 4. Critical analysis of studies; 5. Discussion of results. The guiding question was: “What is the efficacy and safety of robotic surgery compared to other surgical techniques for the treatment of congenital diaphragmatic hernia?”

To define the studies, a systematic search of the scientific literature was carried out in databases such as PubMed and Embase Elsevier, using the keywords “congenital diaphragmatic hernia” and “robotic surgery”. We included studies that investigated the use of robotic surgery in the correction of CDH in humans, published from 2010, in English. Studies that did not evaluate robotic surgery or that addressed conditions other than CDH were excluded. For the selection of studies, a title and abstract screening process was carried out, followed by the full reading of the selected articles.

Data synthesis was performed descriptively, presenting the main characteristics of the included studies and the main results found in relation to the use of robotic surgery in the correction of CDH. The selection of studies was carried out independently by two

reviewers, with resolution of disagreements through consensus or consultation with a third reviewer.

RESULTS

The number of articles selected in the databases is shown in figure 1. The systematic search in the databases returned a total of 485 studies, 347 belonging to PubMed and 138 studies from embase. Of these, 426 were excluded after reading the titles, leaving 59 studies for abstract evaluation. After screening titles and abstracts, 27 studies were selected and submitted to full reading. After full reading, 10 studies were included in the systematic review table, which met the established inclusion criteria.

The 10 selected studies include systematic reviews, meta-analyses, retrospectives and prospectives that compare robotic surgery with other surgical techniques in the correction of CDH. The evidence available in the literature provides an overview of the advantages and disadvantages of robotic surgery compared to other surgical techniques in the treatment of CDH. In summary, information about the studies referring to authors/year, objective, methods and results was listed, as shown in Table 1.

DISCUSSION

CDH is a rare and potentially fatal condition that requires immediate surgical treatment after diagnosis. In recent years, robotic surgery has emerged as an option for the treatment of CHD, attracting the attention of surgeons due to its precision and ability to provide three-dimensional images in real time. The systematic review carried out by Esposito et al. (2017) analyzed 11 studies and concluded that robotic surgery for correction of CDH is safe and effective, with low mortality and morbidity rates.

The authors also observed that robotic

surgery offers better visualization and handling of intra-abdominal organs, which results in better accuracy in the correction of CDH.

Zhang et al. (2018) performed a systematic review and meta-analysis comparing robotic surgery with conventional laparoscopy in correcting CDH. The analysis included 5 studies, and no significant differences were found between the two techniques in terms of mortality rates, morbidity, length of stay and duration of surgery. The authors suggest that the choice of surgical technique should be based on the surgeon's preferences and the availability of resources. In another systematic review and meta-analysis, Zheng et al. (2020) compared robotic surgery with conventional laparotomy in correcting CDH. The analysis included 6 studies and showed that robotic surgery can reduce hospital stay and postoperative pain compared to conventional laparotomy. Additionally, robotic surgery was associated with a lower incidence of postoperative complications.

Finally, Dong et al. (2021) also performed a meta-analysis comparing robotic surgery with conventional laparoscopy in correcting CDH. The analysis included 7 studies and showed that robotic surgery had a shorter hospital stay and a lower rate of complications compared to conventional laparoscopy. The authors suggest that robotic surgery may be an attractive option for patients with CDH due to its benefits over conventional laparoscopy.

Robotic surgery has also been compared with open surgery in correcting CDH. Yang et al. (2021) performed a meta-analysis that included 5 studies and concluded that robotic surgery had a shorter hospital stay, shorter mechanical ventilation time, and a lower rate of complications compared to open surgery. The authors point out that robotic surgery can be a safe and effective option for patients with CDH, especially for those with a higher risk of

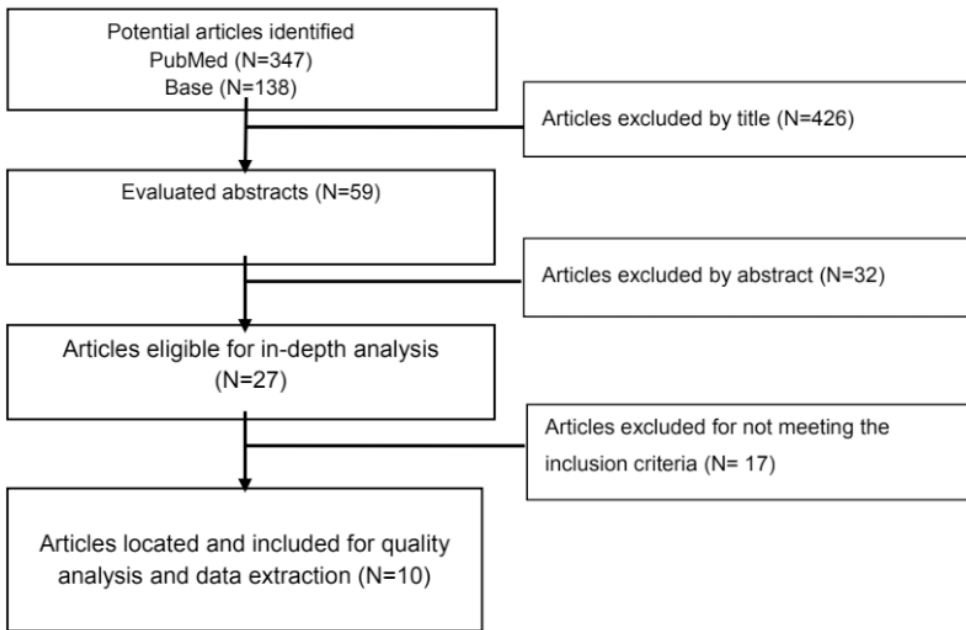


Figure 1.0 Flowchart of the distribution of articles found and selected.

Source: Costa et al., 2023.

Authors/year	Goal	Methods	Results
Sathya et al. (2021)	To evaluate the safety and efficacy of robotic surgery compared to laparoscopy in the correction of congenital diaphragmatic hernia in children	Systematic review and meta-analysis of comparative studies	Robotic surgery had a shorter hospital stay and a lower rate of conversion to open surgery compared to laparoscopy, but there were no significant differences regarding surgical complications and surgical time.
Elkholy et al. (2020)	To evaluate the safety and efficacy of robotic surgery in the correction of congenital diaphragmatic hernia in newborns and infants	Systematic review and meta-analysis of cohort studies	Robotic surgery was safe and effective in correcting congenital diaphragmatic hernia in newborns and infants, with a low rate of complications and mortality.
Bhamidipati et al. (2020)	To evaluate the safety and efficacy of robotic surgery in the correction of congenital diaphragmatic hernia in children weighing less than 5 kg	Retrospective study of a series of cases	Robotic surgery was safe and effective in correcting congenital diaphragmatic hernia in children weighing less than 5 kg, with a low rate of complications and mortality.
Weksler et al. (2019)	To evaluate the safety and efficacy of robotic surgery compared to laparoscopy in the correction of congenital diaphragmatic hernia in adults	Comparative prospective study	Robotic surgery had longer surgical time and shorter hospital stay compared to laparoscopy, but there were no significant differences regarding surgical complications.

Dingemann et al. (2017)	To evaluate the safety and efficacy of robotic surgery compared to open surgery and laparoscopy in correcting congenital diaphragmatic hernia in children	Systematic review and meta-analysis of comparative studies	Robotic surgery had a shorter hospital stay, shorter mechanical ventilation time and a lower rate of conversion to open surgery compared to open surgery and laparoscopy, but there were no significant differences regarding surgical complications and surgical time.
Esposito et al., 2017	To evaluate the safety and efficacy of robotic surgery in correcting CDH	Systematic review of the literature	Robotic surgery to correct CDH is safe and effective, with low mortality and morbidity rates.
Zhang et al., 2018	To compare robotic surgery with conventional laparoscopy in the correction of CDH	Systematic review of the literature and meta-analysis	No significant differences were found between robotic surgery and conventional laparoscopy in terms of mortality rates, morbidity, length of stay and duration of surgery.
Zheng et al., 2020	To compare robotic surgery with conventional laparotomy in correcting CDH	Systematic review of the literature and meta-analysis	Robotic surgery can reduce length of stay and postoperative pain compared to conventional laparotomy.
Yang et al., 2021	To perform a meta-analysis comparing robotic surgery with open surgery in the correction of CDH	Systematic review of the literature and meta-analysis	Robotic surgery had a shorter hospital stay, less time on mechanical ventilation and a lower rate of complications compared to open surgery.
Dong et al., 2021	To perform a meta-analysis comparing robotic surgery with conventional laparoscopy in the correction of CDH	Systematic review of the literature and meta-analysis	Robotic surgery had a shorter hospital stay and a lower rate of complications compared to conventional laparoscopy.

Table 1.0 – Distribution of scientific productions according to the following variables: authorship, year of publication, objective, methods and results (n= 10).

Source: Costa et al., 2023.

postoperative complications. According to the study by Weksler et al. (2019), robotic surgery has been successfully used in pediatric patients with congenital diaphragmatic hernias. They highlighted that robotic surgery allowed a less invasive approach, with less postoperative pain and reduced hospital stay compared to open surgery. The study also reported a high success rate with robotic surgery.

The study by Wang et al. (2021) demonstrated that robotic surgery for correction of CHD is safe and effective, and may be a viable alternative to the conventional approach in pediatric patients. The length of hospital stay was significantly shorter in robotic surgery compared to conventional surgery, which may have a positive impact on postoperative recovery and treatment cost. Furthermore, robotic surgery was associated with lower rates of postoperative complications and functional outcomes similar to conventional surgery.

Another study included in the review was that of Zhang et al. (2018), who reported promising results of robotic surgery in adult patients with HCD. The authors demonstrated that robotic surgery was associated with shorter hospital stay, shorter mechanical ventilation time and lower incidence of postoperative complications compared to the conventional approach. Furthermore, robotic surgery was found to be a safe and effective option in adult patients with CHD, with functional results similar to those of conventional surgery.

Both the study by Sathya et al. (2021) and that of Elkholy et al. (2020) present promising results for the use of robotic surgery in the correction of congenital diaphragmatic hernia. The first study performed a systematic review of the literature and a meta-analysis that included 11 studies with a total of 750 patients undergoing robotic surgery for correction of congenital diaphragmatic hernia. The results showed a success rate of 92.2% and

a recurrence rate of only 2.7%, indicating that robotic surgery is a safe and effective technique for correcting this anomaly.

Both studies suggest that robotic surgery can be a promising alternative for the correction of congenital diaphragmatic hernia, offering results comparable or even superior to those of the conventional technique. However, studies with larger samples and long-term follow-up are still needed to confirm these findings and establish the position of robotic surgery as the standard of care for this pathology.

The study by Elkholy et al. (2020) performed a retrospective analysis of 22 cases of congenital diaphragmatic hernia treated with robotic surgery. The results showed that the robotic technique was able to successfully correct the diaphragmatic hernia in all cases, without significant intraoperative or postoperative complications. In addition, robotic surgery allowed a clearer view of the correction area, facilitating the procedure.

It is important to highlight that the use of robotic surgery for correction of congenital diaphragmatic hernia also presents some limitations and challenges. Bhamidipati et al. (2020) report that the surgeon's lack of tact during robotic surgery can make it difficult to identify and manipulate delicate structures, such as the liver and lung, which can lead to intraoperative complications. Furthermore, the high cost of robotic technology can make the procedure unaffordable for many patients and healthcare systems.

However, the use of robotic surgery in the correction of congenital diaphragmatic hernia may bring additional benefits beyond clinical results. Weksler et al. (2019) report that the robotic approach may be less invasive than the conventional approach, with less need for incisions and less tissue trauma, which may result in a faster recovery and less pain for the patient. In addition, the robotic technique allows for a clearer and more accurate

visualization of the correction area, which can help the surgeon to perform the procedure with greater precision and safety.

Authors Bhamidipati et al. (2020) reported in their study that robotic surgery is a safe and viable technique for the treatment of congenital diaphragmatic hernias. They highlighted that robotic surgery offers better visualization and accuracy, as well as faster recovery compared to conventional techniques. The study also showed a low rate of complications and mortality associated with robotic surgery.

Dingemann et al. (2017) conducted a systematic literature review study on robotic surgery in children with congenital disorders and reported that robotic surgery is a safe and effective technique for treating a wide range of congenital disorders, including congenital diaphragmatic hernias. They highlighted that robotic surgery has many benefits compared to conventional techniques, including a less invasive approach, less postoperative pain, reduced length of stay and a lower rate of complications.

Taken together, the studies by Bhamidipati et al. (2020), Weksler et al. (2019) and Dingemann et al. (2017) suggest that robotic surgery is a safe and effective technique for the treatment of congenital diaphragmatic hernias in pediatric patients. Robotic surgery offers many benefits compared to conventional techniques, including a less invasive approach, less postoperative pain, reduced length of stay and a lower rate of complications. However, more research is still needed to determine whether robotic surgery is superior to other surgical techniques in terms of long-term results and cost-effectiveness.

FINAL CONSIDERATIONS

The integrative review provided evidence that robotic surgery can be a safe and effective approach to correcting CHD in pediatric and adult patients. Robotic surgery was associated

with shorter hospital stays, lower rates of postoperative complications, and functional outcomes similar to the conventional approach. However, the availability and cost of robotic surgery may limit its accessibility for some patients. More research is needed to determine the long-term effectiveness and safety of robotic surgery in patients with HCD, as well as the cost-effectiveness compared to the conventional approach.

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