European Archives of Oto-Rhino-Laryngology (2022) 279:5449–5456
https://doi.org/10.1007/s00405-022-07514-4

SHORT COMMUNICATION

Transoral robotic cordectomy for glottic carcinoma: a rapid review

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Received: 20 February 2022 / Accepted: 14 June 2022 / Published online: 22 June 2022

Abstract

Objective The objective of this study was to investigate feasibility, surgical, oncological, and functional outcomes of transoral robotic cordectomy (TORS-Co) and whether TORS-Co reported comparable outcomes of transoral laser microsurgery (TLM).

Methods PubMed, Scopus, and Cochrane Library were searched by three laryngologists for studies investigating feasibility, surgical, oncological, and functional outcomes of patients benefiting from TORS-Co. The following outcomes were investigated according to the PRISMA statements: age; cT stage; types of cordectomy; surgical settings; complications; and functional and feasibility features.

Results Nine studies published between 2009 and 2021 met our inclusion criteria, accounting for 114 patients. There was no controlled study. TORS-Co was performed in cT1 or cT2 glottic cancer through types II, III, IV, V, or VI cordectomies. The exposure was inadequate in 4% of cases, leading to conversion in transoral laser cordectomy. Margins were positive in 4.5% and local recurrence occurred in 10.7% ($N=8/75$). Tracheotomy and feeding tube requirement varied across studies, depending on the types of TORS-Co. The mean duration of robot installation/vocal cord exposure and operative times ranged from 20 to 42 min and 10 to 40 min, respectively. The mean duration of hospital stay ranged from 2 to 7 days. Complications included dyspnea, bleeding, granuloma, synechia, and tongue hematoma and dysesthesia.

Conclusion The current robotic systems do not appear adequate for TORS-Co. TORS-Co was associated with higher rates of complications and tracheotomy than TLM.

Keywords Cordectomy · Cancer · Larynx · Laryngeal · Laryngology · Robot · Robotic · TORS · Otolaryngology · Head and neck surgery

Introduction

Transoral laser CO_2 microsurgery (TLM) is the surgical standard of care for early glottic squamous cell carcinoma (GSCC). According to large cohort studies, TLM is safe, effective, and reports adequate local and regional controls, overall survival (OS), and disease-free survival (DFS) [1–4]. The success of TLM involves many points, i.e. glottic exposure, tumor location and invasion, and skills and experience of laryngeal surgeon [5]. Through the development of transoral robotic surgery (TORS), surgeons had an additional surgical approach for some head and neck cancers with shorter hospital stay duration [6, 7]. The main strengths of TORS are the 3D view of the surgical field, and the better movement amplitude and precision [6]. The feasibility of TORS in glottic surgery was demonstrated by O'Malley et al. in a canine model in 2006 [8]. Since then, only a few

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case-series or case reports of TORS cordectomy (TORS-Co) were published, yielding the place of TORS-Co not yet defined.

The aim of this rapid review was to investigate feasibility, surgical, oncological, and functional outcomes of TORS-Co and whether TORS-Co reported comparable outcomes of transoral cordectomy.

Methods

The criteria for consideration of paper inclusion were based on the population, intervention, comparison, outcome, timing, and setting (PICOTS) framework [9]. Data of study were independently reviewed by three laryngologists (JRL, RB, and CMCE) and extracted according to the PRISMA checklist for systematic reviews [10].

Patient population

Prospective and retrospective, controlled, uncontrolled, or randomized studies published between January 2000 and January 2022 were included if authors investigated feasibility, surgical, oncological, or functional outcomes of patients benefiting from TORS-Co for GSCC using the Da Vinci Robot platform (Intuitive Surgical, Norcross, GA, USA). In case-series reporting outcomes from different laryngeal tumor locations, authors only focused on patient data of GSCC. The studies had to be published in English, Spanish, or French peer-reviewed journals. Case reports were considered in the analysis. The type of study was classified according to the levels of evidence for prognostic studies (I–V) [12].

Intervention and comparison

The following approaches were reviewed for each study: TORS-Co types; radiation; or combined treatments. The type of cordectomy was identified regarding the European Laryngological Society Classification [11]. Types I and II are subepithelial and subligamental resections, respectively. Type III cordectomy consists of transmuscular resection and may involve partial resection of the ventricular fold (adequate exposure). In type IV, the entire vocal cord is excised. Types Va, b, c, and d consist of extended cordectomies encompassing the contralateral vocal fold (a), the arytenoid (b), ventricle (c), or subglottis (d), respectively. The anterior commissure of the vocal folds is excised in type VI.

Outcomes

The following outcomes were reviewed: number of patients; mean age; tumor stage; type of TORS-Co; exposure details; success of surgery; robot setting time and exposure; surgery duration; pathological characteristics (margins); tracheotomy; feeding tube; blood loss; hospital stay duration; complications; and any functional and oncological outcomes.

The Tool to Assess Risk of Bias in Cohort Studies developed by the Clarity Group and Evidence Partners was used by two authors (JRL & CC) for the bias/heterogeneity analyses of the included studies [13]. The bias analysis consisted of evaluation of cofactors that may impact the conclusion of studies.

Timing and Setting

The patients had early-stage GSCC available for a surgical treatment.

Search strategy

The paper search was conducted with PubMED, Scopus, and Cochrane databases by three independent laryngologists ((JRL, RB, and CMCE). Databases were screened for abstracts and titles referring to the inclusion criteria of the present study. Authors analyzed full texts of the selected publications. Any discrepancies in synthesized data were discussed and resolved by the senior author. The following keywords were included: 'TORS'; 'Robot'; 'Robotic'; 'Cordectomy'; 'larynx'; 'laryngeal'; 'cancer'; carcinoma'; 'Surgery'; 'outcome.'

Results

Nine papers published between 2009 and 2022 met our inclusion criteria, accounting for 114 patients (Fig. 1) [14–22]. There were 4 retrospective chart reviews (EL: IV) [18, 20–22] and 3 prospective uncontrolled studies (EL: III) [2, 17, 19], respectively. Two case reports were included [15, 16]. The features of studies are described in Table 1. The mean age of individuals was 56.1 yo. According to studies, the following types of TORS-Co were performed: type II [15, 18, 19, 21, 22], III [17–19, 21, 22], IV [14, 17, 21, 22], V [14, 20], and VI [16, 18, 20] for cT1 or cT2 GSCC. The exposure was inadequate in 4% of cases, leading to conversion in transoral laser cordectomy [22]. In this report, the problem was related to the length of the robotic arm to reach the vocal fold or the inability to see the lesion because of large base of tongue [22]. Various instruments were used to get adequate exposure of the vocal folds, including FK retractor [14, 16–22], Lindholm laryngoscope [15], tongue blade [19], or Wollenberg laryngeal blade [16, 19]. The robot installation and vocal fold exposure time ranged from 26 to 42 min. The surgical time, defined as the time use for the tumor exeresis ranged

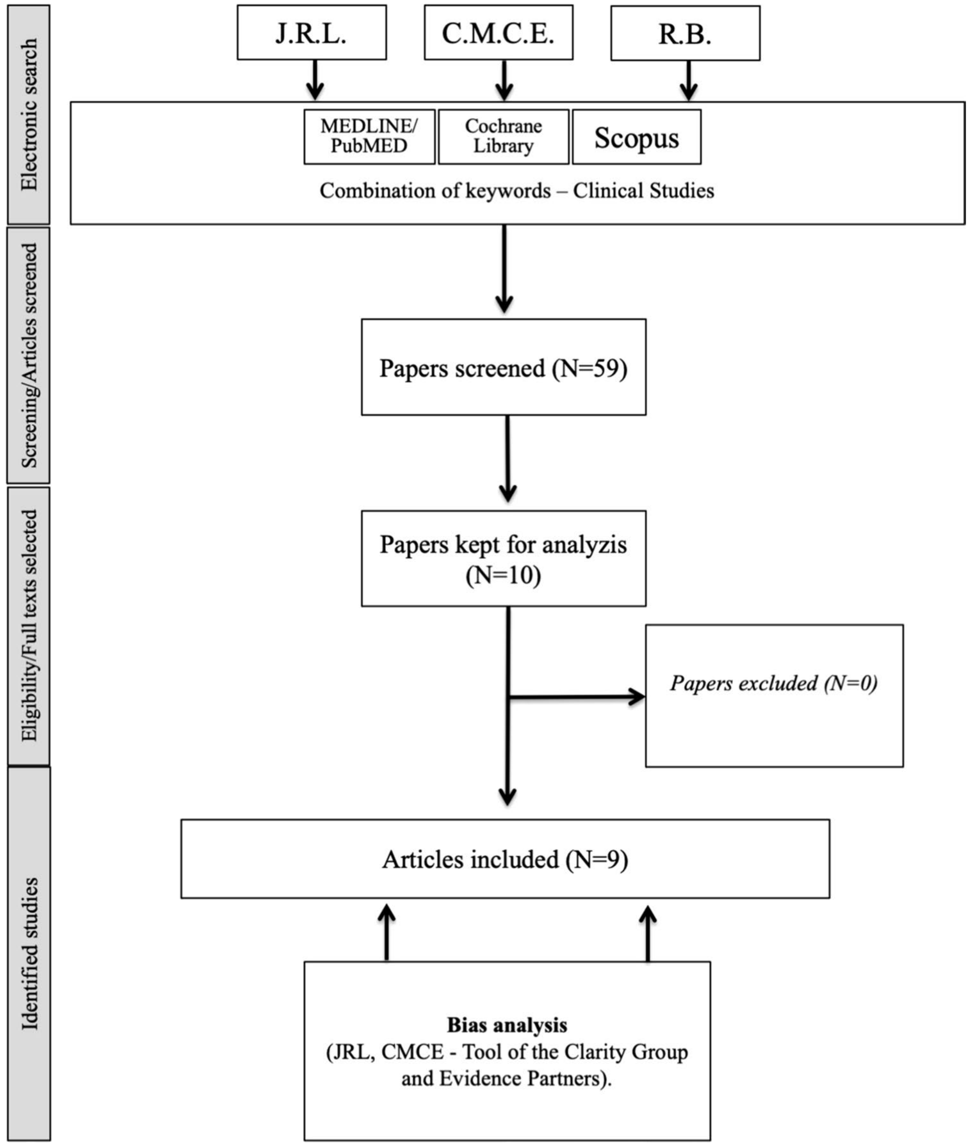

Fig. 1 Chart flow

from 10 to 40 min. The mean blood loss during the surgery was reported in four papers and ranged from 0 to 20 mL [14, 17, 21, 22]. The pathological findings were available in eight publications [14–20, 22]. Margins were positive in three cases (4.5%).

The mean hospital stay duration of studies was 3.25 days (range 2–7 days). Tracheotomy was required in 25 cases (22.3%) and was removed after a mean of 7.1 days. Feeding tube was required in 15 patients (15.8%) and was removed after a mean of 9.3 days. Gastrostomy was used in one patient [16]. Complications were reported in five papers, consisting of granuloma ($N=6$), postoperative bleeding ($N=2$), dyspnea ($N=1$), synechia ($N=1$), tongue hematoma ($N=1$), and dysesthesia ($N=1$) (Table 1) [17, 18, 20–22]. According to the low number of included patients, many authors did not report survival findings. Overall, local recurrence occurred in 10.7% ($N=8/75$).

Bias and limitation analysis

Studies are all retrospective chart review (EL: IV) with a low number of patients. There was no controlled study comparing TORS-Co with TLM. Heterogeneity among studies in exclusion criteria information, surgical step time and features, complication, and postoperative care outcomes are reported in Table 2. There was an important heterogeneity across studies regarding the type of included cordectomy (Table 1). Moreover, many important outcomes that may influence the occurrence of complications, surgical, or oncological outcomes were not reported in all studies, including tobacco consumption, comorbidities, or history of previous cancer or radiation. The observation of complications may be influenced by the follow-up of patients, which may substantially differ from one to another study. No author reported medical postoperative cares (drugs), which may

Table 1 Study features

Authors	Design	*N* (age)	cT stage	Setting	S/F	IT	Functional	Complications	Recurrence
Park, 2009 [14]	Prospective Uncontrolled	3 (57)	cT1 cT2 Types IV, V	FK retractor (3) 3 arms	3/0	20 min	SD: 21 min Margin: R0 (2), R1 (1) Tracheotomy: 3 (7d) Feeding tube: 3 (6d) Blood loss: 0 mL Hospital stay: 6 d	No	1 local
Blanco, 2011 [15]	Case report	1 (73)	cT1 Type II	Lindholm Laryngoscope 3 arms	1/0	35 min	SD: 10 min Margin: R0 (1) Tracheotomy: 0 Feeding tube: 0 Blood loss: NA Hospital stay: 2 d	No	N.A
Vural, 2012 [16]	Case report	1 (63)	cT2 Type VI	FK retractor & Wollenberg laryngeal blade (1) 3 arms	1/0	N.A	SD: N.A Margin: R0 (1) Tracheotomy: 1 (28d) Gastrostomy: 42 (7d) Blood loss: NA Hospital stay: 7 d	No	No
Kayhan, 2012 [17]	Prospective Uncontrolled	10 (58)	cT1 Types III IV	FK retractor (10) 3 arms	10/0	42 min	SD: 21 min Margin: R0 (10) Tracheotomy: 1 (3d) Feeding tube: 1 (4d) Blood loss: < 20 mL Hospital stay: 4 d	Dyspnea (1)	No
Lallemant, 2013 [18]	Retrospective	13 (62)	cT1 cT2 Type II, III, VI	FK retractor (13) 3 arms	13/0	32 min	SD: 40 min Margin: R0 (6), R1 (2), N.A. (4) Tracheotomy: 1 (15d) Feeding tube: 3 (5d) Blood loss: NA Hospital stay: 5 d	Bleeding (1)	2 local
De Virgilio, 2013 [19]	Prospective Uncontrolled	18 (66)	cT1 cT2 Type II-III	FK retractor & Wollenberg laryngeal blade (10) or Tongue blade (8) 3 arms	18/0	N.A	SD: 40 min Margin: R0 (8) Tracheotomy: 18 (8d) Feeding tube: N.A Blood loss: NA Hospital stay: NA	N.A	N.A
Wang, 2016 [20]	Retrospective	8 (66)	cT1 cT2	FK retractor (8) 3 arms	8/0	N.A	SD: N.A Margin: R0 (8)	Granuloma (6)	1 node

Table 1 (continued)

Authors	Design	*N* (age)	cT stage	Setting	S/F	IT	Functional	Complications	Recurrence
			Type V, VI				Tracheotomy: 0 Feeding tube: 7 (14d) Blood loss: NA Hospital stay: 3.9 d		
Kayhan, 2018 [21]	Retrospective	48 (60)	cT1 cT2 Type II-IV VI	FK retractor (48) 3 arms	48/0	37 min	SD: 13 min Margin: N.A Tracheotomy: 1 ((3d) Feeding tube: 1 (5d) Blood loss: 10 mL Hospital stay: 2.6 d	Synechia Bleeding	5 local
Hans, 2021 [22]	Retrospective	12 (56)	cT1 Type II-IV	FK retractor (10) 3 arms	8/4	26 min	SD: 30 min Margin: R0 (8) Tracheotomy: 0 Feeding tube: 0 Blood loss: 20 mL Hospital stay: 2 d	Tongue hematoma (1) Tongue dysesthesia (1)	No

IT installation time, *min* minutes, *mL* milliliter, *NA* not available, *SD* surgery duration

Table 2 Bias analysis

Authors	Exclusion	Surgery details/times			Complications	Postoperative
	Criteria	Docking	Exposure	Time	Details	Cares
Park [14]	Yes	Probably yes	Probably yes	Yes	Yes	No
Blanco [15]	No	Yes	Yes	Yes	Yes	No
Vural [16]	No	No	No	No	Yes	No
Kayhan [17]	No	Probably yes	Probably yes	Yes	Yes	No
Lallemant [18]	Yes	Yes	Probably yes	Yes	Yes	No
De Virgilio [19]	No	No	Probably yes	Yes	No	No
Wang [20]	Yes	No	No	No	Yes	No
Kayhan [21]	Yes	Probably yes	Probably yes	Yes	Yes	No
Hans [22]	Yes	Probably yes	Probably yes	Yes	Yes	No

Bias analysis was performed through the Tool to Assess Risk of Bias in Cohort Studies, which grade each component with the following assessments: no, probably no, probably yes, and yes. The following criteria were used for analyzing the exclusion criteria description: no = authors did not report exclusion criteria; yes = authors reported exclusion criteria. The following criteria were used for analyzing the description and definition of complications: no = authors did not report complication information; probably no = authors reported complication but without providing clear definition of the complication or the timing of occurrence; probably yes = authors reported complication with a clear definition of the complication or specific data about the timing of occurrence; and yes = authors reported well-defined complication(s) with the timing of occurrence. The following criteria were used for analyzing the postoperative cares: no = authors did not provide information about the postoperative medical cares (drugs, intubation, diet); probably no = authors reported few information about the postoperative cares; probably yes = authors provided most of the following information: drugs, intubation, and diet; and yes = the postoperative cares have been extensively provided. The following criteria were used for analyzing the surgery details: no = authors did not provide information about the surgery details (docking time, exposure time/details or time of surgical step); probably no = authors provided few information; probably yes = authors provided most of the following information: time of docking and time of exposure; and yes = the surgery details have been extensively provided respecting independent outcomes for step time impact postoperative outcomes, such as complications or hospital stay duration. The comparison of outcomes between TORS and TLM approach has to consider the experience of surgeons and the differences between learning curves. The lack of such information and the surgeon experience differences between TLM (long experience) and TORS (short experience) studies may be an additional comparative bias.

Discussion

Transoral robotic surgery is increasingly recognized as an interesting approach for some pharyngeal and supraglottic SCCs because of shorter hospital stay duration, better diet and respiratory outcomes, and similar oncological outcomes than conventional open surgery. However, the usefulness of TORS in glottic lesion is still undefined. In this rapid review, we summarized the current findings available in the literature about TORS-Co. The primary finding is the lack of controlled study comparing TORS-Co and TLM, which remains the standard of care in GSCC. Thus, we may just discuss the findings of our review according to the TLM findings of literature publications.

First, the duration of hospital stay ranged from 2 to 7 days because of post-TORS monitoring, placement of feeding tube, or tracheotomy. On one hand, most TLMs do not require long hospital stay and may be performed in ambulatory hospitalization type [23]. On the other hand, feeding tube and tracheotomy are not required in most TLMs irrespective to the cordectomy type [4, 23–25]. The rate of 22% of tracheotomy in TORS-Co literature is an important limit of the ability of the current robotic systems to perform vocal fold surgery (Da Vinci S, Si, Xi, or Medrobotics). Longer hospital stay, cost of robot, and feeding tube/tracheotomy requirement are the most important disadvantages of TORS-Co over TLM approach.

Second, considering robotic docking, glottic exposure and surgical times, the total time of TORS-Co varied from 30 to 82 min, which appears to be substantially longer than the time for TLM [5, 26]. The shorter time of TLM is also related to the longer experience of surgeons who performed TLM since many years [5, 26]. The difficulty of exposure of the glottic area is a surgical step of TORS-Co that may support the longer total surgical time [22]. In this review, we observed that a few authors really reported exposure difficulty outcomes. Interestingly, in the study of Hans et al., the exposure of glottic plan was inadequate in two patients, leading to TLM conversion. Kayhan et al. excluded two patients (20%) for similar reasons [17]. In both cases, authors reported difficulties for the robotic arms to reach the glottic plan, and the lack of precision in the surgical dissection of type II cordectomy [17, 22]. Nowadays, many authors agreed to state that the main reasons to not perform TORS-Co remain anatomical outcomes (hypertrophy of base of tongue and inability to expose the glottic surgical field), cost of robot, and technical conditions (size of robot arms) [22].

Third, considering data of all included studies, complications occurred in 12.6% of cases and 22% of patients had tracheotomy. The reported complications included dyspnea, granuloma, synechia, bleeding, tongue hematoma, and dysesthesia. The complication rate as well as the tracheotomy rate are both higher than those of TLM studies [23–25].

Four, the data of the studies included in this rapid review did not allow to summarize outcomes about disease-free survival or overall survival. The pathological data supported positive margins in 4.5% of cases, which appears in the same order of magnitude and even lower than reported in TLM studies—11.9% in 595 patients in Peretti et al. and 24.06% in 590 patients in Ansarin et al., for instance [5, 24, 25]. Local recurrence may reach 10% of cases as reported in TLM studies—16.8% in Peretti et al. and 12.0% in Ansarin et al. [24, 25].

The comparison of the reviewed data with the literature remains difficult because in both TORS-Co and TLM publications, the proportion of type I to VI cordectomy varied, leading to substantial heterogeneity between studies. No study investigated voice quality outcomes, which are, however, important findings. These unconsidered factors and additional lacking information (comorbidities, etc.) limit us in the draw of clear conclusion. The learning curve outcome is moreover important to report in studies according to reports highlighting the importance of learning curve of physician in TORS [26, 27].

To date, the main indications for TORS in Head and Neck Surgery are oropharyngeal [29], and supraglottic cancer [30, 31], which are the subject of several hundred reports in the literature [31, 32]. The present systematic review included only 114 cases of TORS-Co, which considerably limits the draw of conclusion. The low number of studies is therefore the primary limitation of this study. Another limitation is the lack of study using the *Da Vinci* Single-port Robot, which could be associated with less disadvantages about glottic exposure and movement of the robotic arms.

Conclusion

The current robotic systems, i.e. *Da Vinci* or Medrobotics, do not appear to be ideal for TORS-Co. Especially, the use of *Da Vinci* system for cordectomy was associated with a high rate of tracheotomy, which represents an important limit of TORS-Co. Margin and local recurrence rates appear to be comparable, while complication rate was higher than TLM. Better robotic systems are needed to ensure the realization of TORS-Co with similar pre- and post-operative outcomes than TLM.

Declarations

Conflict of interest The authors have no conflict of interest.

Research involving human participants and/or animals IRB was not required for this study.

Informed consent Patients agreed to participate.

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