

A 9-year analysis of transoral laser microsurgery (TLM) of head and neck cancer on their potential suitability for transoral robotic surgery (TORS) for estimation of future TORS-specific caseload

F. VON SCOTTI, M. KAPSREITER, C. SCHERL, H. IRO, C. BOHR

Department of Otorhinolaryngology, Head and Neck Surgery, Universitätsklinikum Erlangen, Friedrich-Alexander University of Erlangen-Nürnberg (FAU), Erlangen, Germany

Abstract. – OBJECTIVE: After that, the establishment of transoral robotic surgery (TORS) for head and neck cancer has been adopted in North America, it has also recently been adopted in Europe. In these parts, transoral laser microsurgery (TLM) is widely applied. The aim of the study was to identify the absolute number of operations amenable to TORS at a TORS initiating institution on the basis of all former TLM cases.

PATIENTS AND METHODS: All laser surgery procedures from May 2004 to April 2013 (108 months) were initially retrospectively registered; after that, all stage pT1 and pT2 squamous cell carcinomas of the oropharynx, hypopharynx, and larynx were selected.

RESULTS: Over a period of nine years out of all TLM cases, there were 45 cases of pT1 and pT2 oropharyngeal and supraglottic squamous cell carcinomas, which could have been considered for TORS surgery. With the inclusion of a nowadays-typical TORS indication such as tonsil cancer, 142 cases would have been amenable to TORS.

CONCLUSIONS: The indication for TORS would have been made in five of the TLM cases per year. Institutions initiating TORS, which own an intensive TLM experience, are encouraged to TORS indications in more than solely typical TLM indications. By indicating TORS instead of hand-held surgery, a higher caseload of more than 15 cases per year can be achieved for TORS indications.

Key Words:

Robotics, TORS, Transoral laser, Head and neck cancer, Carcinoma, Indication.

in all anatomical locations¹⁻¹¹. Its introduction in 1979 for early stages of laryngeal cancer can be regarded as the start of the laser movement¹². Although CO₂ laser surgery was initially only intended for use in individual cases, its indications were soon extended¹³. It provided good exposure and visible tumor margins in early-stage cancer of the larynx, oropharynx, and oral cavity. The advantages at that time were the avoidance of tracheotomy, maintenance of function, reduction of surgery time and retention time of the gastric tube, as well as shortening of the duration of post-operative hospitalization and a low complication rate¹². Nowadays corresponding advantages are seen in transoral robotic surgery (TORS) using the da Vinci® system¹⁴⁻¹⁷. Because of the encouraging results of this alternative transoral resection modality, TORS is experiencing a surge in use in Europe¹⁸⁻²⁰. In times of economic pressure, a cost comparison revealed that TORS is more expensive than TLM and the cost is mostly influenced by equipment²¹. In Germany, the da Vinci® system is used multidisciplinary. In these parts, the organizational and financial requirements are relatively high for head and neck departments as there is no reimbursement for using this system. It should be borne in mind that the irregular use of the da Vinci® system and the surgical team clearly makes establishing a routine difficult. Against this background, the purpose of this study was to estimate the future TORS-specific caseload on the basis of a high experience in TLM since many centuries. Comparable cases could represent the indications for TORS at our department in future. For answering this question, all laser surgery procedures over the period of nine years undertaken at our institution were retrospectively assessed as to their suitability for TORS.

Introduction

Transoral CO₂ laser microsurgery (TLM) is an established resection technique capable of achieving good oncological and functional results

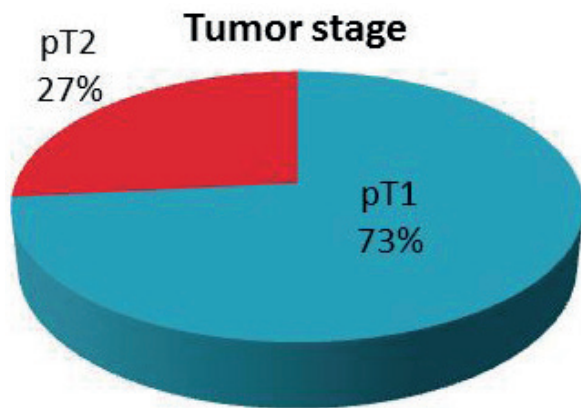


Figure 1. Tumor stage: 33x pT1, 12x pT2 (n=45).

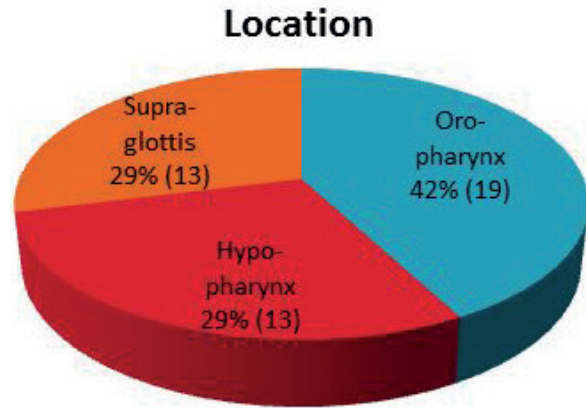


Figure 2. Tumor location: 19x oropharynx, 13x hypopharynx, 13x supraglottis (n=45).

Patients and Methods

Patients

According to the inclusion criteria when TLM was established¹², the indications for the introduction of TORS at our department would include early oropharyngeal cancer as well as supraglottic larynx tumors. Corresponding to these criteria laser surgery procedures were retrospectively selected. For this purpose, all laser surgery procedures from May 2004 to April 2013 (108 months) were initially registered. Then, all stage pT1 and pT2 squamous cell carcinomas of the oropharynx, hypopharynx, and larynx were selected. Isolated glottic carcinomas were excluded and the resulting patient population represented all laser-resected oropharyngeal, hypopharyngeal, and supraglottic carcinomas.

Results

Over a period of nine years, a total of 339 pT1 and pT2 squamous cell carcinomas of the oropharynx, hypopharynx, and larynx were resected using TLM. After excluding the glottis as a surgical site, a total of 45 cases of laser-resected oropharyngeal, hypopharyngeal, and supraglottic carcinomas remained. 33 were pT1 and 12 were pT2 stage (Figure 1). The oropharynx was affected in 19 cases, the hypopharynx in 13, and the supraglottis in 13 cases (Figure 2).

Of the 19 oropharyngeal carcinomas (15x pT1, 4x pT2), 12 involved the base of the tongue or the epiglottic vallecula. An initial R1 situation requiring wider excision to achieve an R0 situation was present in 5 of the 45 cases (2x base of the

tongue, 2x supraglottis, 1x hypopharynx). Figure 3 demonstrates the preoperative CT scan of a R1 resected pT2 base of the tongue carcinoma.

Discussion

A contemporary analysis of surgical trends from 1998-2012 with nearly 85.000 included patients showed that, since FDA approval for TORS in 2009, surgical rates have increased by 7.9% for stage I and by 11.3% for stage II oropharyngeal carcinoma²². TORS procedures particularly increase at centers which have so far not participated in the culture of laser surgery and TORS can offer an extension of surgical indications with shifting paradigm in the treatment of head and neck cancer²³⁻²⁵. Even a possible superiority over laser surgery is discussed in oropharyngeal cancer, regarding the procedure itself and the local tumor control^{14,26}.

There is no retrospective study in the current literature assessing the suitability of laser-resected head and neck tumors for TORS. In the present study, we included 45 cases amongst the pT1 and pT2 squamous cell carcinomas of the oropharynx, hypopharynx, and supraglottic larynx over a period of nine years. Considering the long-standing period of established laser surgery of this institution since 1979, the collected data may be regarded as being representative^{1-3,25}. There are various reasons for the higher case numbers of current prospective studies in TORS: on the one hand as off-label they also include T3 and T4 tumors and on the other hand they include the location of the glottis^{17,28-32}. Moreover, tonsil carcinoma represents a typical indication for TORS nowa-

days due to the view of a new surgical technique using TORS²³. In our department, these are resected monopolarly or by cold surgery technique. With the inclusion of tonsil carcinoma resection, 97 further cases in our retrospective study would have been amendable to TORS, thus resulting in 142 cases in total.

Besides the excellent 3D-view, improved visualization and dexterity, one of the main advantages of TORS – over the tangential direction of excision of laser surgery – is the ability for the resection of tongue base carcinomas^{24,28,33-35}. Of the 45 cases suitable for TORS surgery, 12 involved the base of the tongue (8x pT1, 4x pT2). These data are in line with those in the literature. Steiner et al³⁵ found only one pT1 and 12 pT2 laser-resected carcinomas of the base of the tongue (n=13) over a period of 12 years at an established center for laser surgery. Canis et al³⁶ found a comparative number of 29 laser-resected carcinomas of the base of the tongue (5x pT1, 24x pT2) over 21 years. Machtay et al³⁷ showed a total of nine carcinomas of the base of the tongue (3x pT1, 6x pT2)

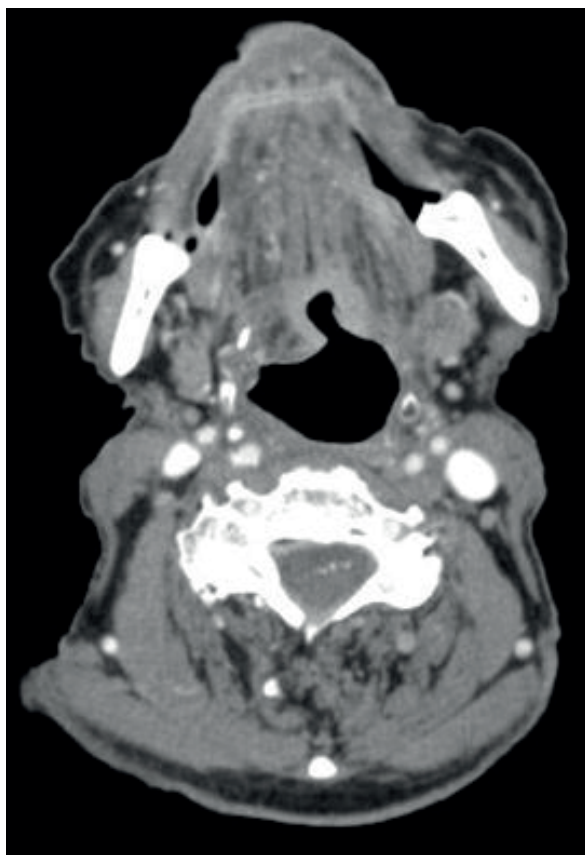


Figure 3. Preoperative CT scan axial view of a R1 resected pT2 base of the tongue carcinoma.

over 11 years with the inclusion of open resection and adjuvant radiation therapy.

Especially in tongue base carcinomas, the angle in the surgical field may hinder the achievement of free margins. Following an initial R1 resection, a wider excision to achieve free margins was undertaken in two of 19 carcinomas of the oropharynx. These were two tongue base carcinomas of stage pT2. In the first case, the surgical report states that the change of surgical access was achieved with the aid of a tonsil retractor and later with a distending laryngoscope. Both the CO₂ laser and the electrical needle had to be used in this case. In the second case, the surgical report reveals that the surgical site was visualized only with difficulty and with the aid of a distending laryngoscope. It was due to the soft consistency of the base of the tongue and the initial R1 situation was located at the caudal resection margin. Interestingly, in these cases a side-viewing endoscope and the flexible direction of incision – gained by the greater degree of freedom – could have been helpful. A wider field of vision like in TORS would presumably have made dissection easier or even would have allowed a primary R0 resection. Steiner et al³⁵ found 19% initial R1 resections of base of the tongue carcinomas with reference to pT1 to pT4 stages. The present investigation included pT1 and pT2 stages, but the proportion of R1 resected base of the tongue carcinomas (17%) is nevertheless comparable. Furthermore, a research³ involving over 134 laser resections of pT1 and pT2 carcinomas of the oropharynx revealed 14% initial R1 resections. This smaller proportion can be explained by the fact that the data include the entire oropharynx, and therefore also the more easily accessible regions. The authors did not assess the R1 resection rate of pure base of the tongue carcinomas individually.

Conclusions

This study conducted at an established center for laser surgery shows that the indication for TORS would have been made for an average of five of the TLM cases per year – based on the current inclusion criteria for TORS surgery. Institutions initiating TORS are encouraged to use TORS in more than solely TLM indications. TORS instead of handheld surgery can result in a higher case load. Depending on the results of prospective studies with head-to-head comparison of TLM and TORS, the use of the da Vinci® System

in head and neck surgery needs to be examined in the light of its logistical requirements and financial costs.

Conflict of Interest

The Authors declare that they have no conflict of interest.

Informed consent

The patient provided written consent for the use of his images.

References

- 1) KARATZANIS AD, WALDFAHRER F, PSYCHOGIOS G, HORNUNG J, ZENK J, VELEGRAKIS GA, IRO H. Effect of repeated laser microsurgical operations on laryngeal cancer prognosis. *Head Neck* 2010; 32: 921-928.
- 2) KARATZANIS AD, PSYCHOGIOS G, ZENK J, WALDFAHRER F, HORNUNG J, VELEGRAKIS GA, IRO H. Evaluation of available surgical management options for early supraglottic cancer. *Head Neck* 2010; 32: 1048-1055.
- 3) IRO H, MANTSOPOULOS K, ZENK J, WALDFAHRER F, PSYCHOGIOS G. [Results of transoral laser resection in T1-2 oropharyngeal, hypopharyngeal and laryngeal carcinomas]. *Laryngorhinootologie* 2011; 90: 481-485.
- 4) STEINER W. Results of curative laser microsurgery of laryngeal carcinomas. *Am J Otolaryngol* 1993; 14: 116-121.
- 5) AMBROSCH P. The role of laser microsurgery in the treatment of laryngeal cancer. *Curr Opin Otolaryngol Head Neck Surg* 2007; 15: 82-88.
- 6) IRO H, WALDFAHRER F, ALTENDORF-HOFMANN A, WEIDENBECHER M, SAUER R, STEINER W. Transoral laser surgery of supraglottic cancer: follow-up of 141 patients. *Arch Otolaryngol Head Neck Surg* 1998; 124: 1245-1250.
- 7) GRANT DG, SALASSA JR, HINNI ML, PEARSON BW, PERRY WC. Carcinoma of the tongue base treated by transoral laser microsurgery, part one: untreated tumors, a prospective analysis of oncologic and functional outcomes. *Laryngoscope* 2006; 116: 2150-2155.
- 8) RICH JT, MILOV S, LEWIS JS JR, THORSTAD WL, ADKINS DR, HAUGHEY BH. Transoral laser microsurgery (TLM) +/- adjuvant therapy for advanced stage oropharyngeal cancer: outcomes and prognostic factors. *Laryngoscope* 2009; 119: 1709-1719.
- 9) HINNI ML, SALASSA JR, GRANT DG, PEARSON BW, HAYDEN RE, MARTIN A, CHRISTIANSEN H, HAUGHEY BH, NUSSENBAUM B, STEINER W. Transoral laser microsurgery for advanced laryngeal cancer. *Arch Otolaryngol Head Neck Surg* 2007; 133: 1198-1204.
- 10) HAUGHEY BH, HINNI ML, SALASSA JR, HAYDEN RE, GRANT DG, RICH JT, MILOV S, LEWIS JS JR, KRISHNA M. Transoral laser microsurgery as primary treatment for advanced-stage oropharyngeal cancer: a United States multicenter study. *Head Neck* 2011; 33: 1683-1694.
- 11) MARCOTULLIO D, DE VINCENTIIS M, IANNELLA G, BIGELLI C, MAGLIULO G. Surgical treatment of T1b glottic tumor, 10-years follow-up. *Eur Rev Med Pharmacol Sci* 2014; 18: 1212-1217.
- 12) STEINER W. Experience in endoscopic laser surgery of malignant tumours of the upper aero-digestive tract. *Adv Otorhinolaryngol* 1988; 39: 135-144.
- 13) STEINER W, JAUMANN MP, PESCH HJ. [Endoscopic laser surgery of the larynx]. *Ther Umsch* 1980; 37: 1103-1109.
- 14) LALLEMANT B, CHAMBON G, GARREL R, KACHA S, RUPP D, GALLY-BERNADOY C, CHAPUIS H, LALLEMANT JG, PHAM HT. Transoral robotic surgery for the treatment of T1-T2 carcinoma of the larynx: preliminary study. *Laryngoscope* 2013; 123: 2485-2490.
- 15) WEINSTEIN GS, O'MALLEY BW JR, MAGNUSON JS, CARROLL WR, OLSEN KD, DAIO L, MOORE EJ, HOLSINGER FC. Transoral robotic surgery: a multicenter study to assess feasibility, safety, and surgical margins. *Laryngoscope* 2012; 122: 1701-1707.
- 16) LEONHARDT FD, QUON H, ABRAHAO M, O'MALLEY BW JR, WEINSTEIN GS. Transoral robotic surgery for oropharyngeal carcinoma and its impact on patient-reported quality of life and function. *Head Neck* 2012; 34: 146-154.
- 17) WHITE HN, FREDERICK J, ZIMMERMAN T, CARROLL WR, MAGNUSON JS. Learning curve for transoral robotic surgery: a 4-year analysis. *JAMA Otolaryngol Head Neck Surg* 2013; 139: 564-567.
- 18) LORINCZ BB, LABAN S, KNECHT R. [The development of TORS in Europe]. *HNO* 2013; 61: 294-299.
- 19) ADELSTEIN DJ, RIDGE JA, BRIZEL DM, HOLSINGER FC, HAUGHEY BH, O'SULLIVAN B, GENDEN EM, BEITLER JJ, WEINSTEIN GS, QUON H, CHEPEHA DB, FERRIS RL, WEBER RS, MOVSAS B, WALDRON J, LOWE V, RAMSEY S, MANOLA J, YUEH B, CAREY TE, BEKELMAN JE, KOSKI AA, MOORE E, FORASTIERE A, SCHULLER DE, LYNN J, ULLMANN CD. Transoral resection of pharyngeal cancer: summary of a National Cancer Institute Head and Neck Cancer Steering Committee Clinical Trials Planning Meeting. *Head Neck* 2012; 34: 1681-1703.
- 20) DE ALMEIDA JR, BYRD JK, WU R, STUCKEN CL, DUVVURI U, GOLDSTEIN DP, MILES BA, TENG MS, GUPTA V, GENDEN EM. A systematic review of transoral robotic surgery and radiotherapy for early oropharynx cancer: a systematic review. *Laryngoscope* 2014; 124: 2096-2102.
- 21) DOMBREE M, CROTT R, LAWSON G, JANNE P, CASTIAUX A, KRUG B. Cost comparison of open approach, transoral laser microsurgery and transoral robotic surgery for partial and total laryngectomies. *Eur Arch Otorhinolaryngol* 2014; 271: 2825-2834.
- 22) LIEDERBACH E, LEWIS CM, YAO K, BROCKSTEIN BE, WANG CH, LUTFI W, BHAYANI MK. A contemporary analysis of surgical trends in the treatment of squamous cell carcinoma of the oropharynx from 1998 to 2012: a report from the National Cancer Database. *Ann Surg Oncol* 2015; 22: 4422-4431.

- 23) WEINSTEIN GS, O'MALLEY BW JR, SNYDER W, SHERMAN E, QUON H. Transoral robotic surgery: radical tonsillectomy. *Arch Otolaryngol Head Neck Surg* 2007; 133: 1220-1226.
- 24) O'MALLEY BW JR, WEINSTEIN GS, SNYDER W, HOCKSTEIN NG. Transoral robotic surgery (TORS) for base of tongue neoplasms. *Laryngoscope* 2006; 116: 1465-1472.
- 25) BHAYANI MK, HOLSINGER FC, LAI SY. A shifting paradigm for patients with head and neck cancer: transoral robotic surgery (TORS). *Oncology* 2010; 24: 1010-1015.
- 26) WEINSTEIN GS, QUON H, NEWMAN HJ, CHALIAN JA, MALLOY K, LIN A, DESAI A, LIVOLSI VA, MONTONE KT, COHEN KR, O'MALLEY BW. Transoral robotic surgery alone for oropharyngeal cancer: an analysis of local control. *Arch Otolaryngol Head Neck Surg* 2012; 138: 628-634.
- 27) KARATZANIS AD, PSYCHOGIOS G, WALDFAHRER F, ZENK J, HORNUNG J, VELEGRAKIS GA, IRO H. T1 and T2 hypopharyngeal cancer treatment with laser microsurgery. *J Surg Oncol* 2010; 102: 27-33.
- 28) LAWSON G, MATAR N, REMACLE M, JAMART J, BACHY V. Transoral robotic surgery for the management of head and neck tumors: learning curve. *Eur Arch Otorhinolaryngol* 2011; 268: 1795-1801.
- 29) ARK YM, KIM WS, BYEON HK, DE VIRGILIO A, LEE SY, KIM SH. Clinical outcomes of transoral robotic surgery for head and neck tumors. *Ann Otol Rhinol Laryngol* 2013; 122: 73-84.
- 30) DZIEGIELEWSKI PT, TEKNOS TN, DURMUS K, OLD M, AGRAWAL A, KAKARALA K, MARCINOW A, OZER E. Transoral robotic surgery for oropharyngeal cancer: long-term quality of life and functional outcomes. *JAMA Otolaryngol Head Neck Surg* 2013; 139: 1099-1108.
- 31) ACHIM V, BOLOGNONE RK, PALMER AD, GRAVILLE DJ, LIGHT TJ, LI R, GROSS N, ANDERSEN PE, CLAYBURGH D. Long-term functional and quality-of-life outcomes after transoral robotic surgery in patients with oropharyngeal cancer. *JAMA Otolaryngol Head Neck Surg* 2017.
- 32) HAY A, MIGLIACCI J, KARASSAWA ZANONI D, BOYLE JO, SINGH B, WONG RJ, PATEL SG, GANLY I. Complications following transoral robotic surgery (TORS): a detailed institutional review of complications. *Oral Oncol* 2017; 67: 160-166.
- 33) VERGEZ S, LALLEMANT B, CERUSE P, MORINIERE S, AUBRY K, DE MONES E, BENLYAZID A, MALLET Y. Initial multi-institutional experience with transoral robotic surgery. *Otolaryngol Head Neck Surg* 2012; 147: 475-481.
- 34) MATTHEIS S, MANDAPATHIL M, ROTHMEIER N, LANG S, DOMINAS N, HOFFMANN TK. [Transoral robotic surgery for head and neck tumors: a series of 17 patients]. *Laryngorhinootologie* 2012; 91: 768-773.
- 35) STEINER W, FIEREK O, AMBROSCH P, HOMMERICH CP, KRON M. Transoral laser microsurgery for squamous cell carcinoma of the base of the tongue. *Arch Otolaryngol Head Neck Surg* 2003; 129: 36-43.
- 36) CANIS M, IHLER F, WOLFF HA, CHRISTIANSEN H, MATTHIAS C, STEINER W. Oncologic and functional results after transoral laser microsurgery of tongue base carcinoma. *Eur Arch Otorhinolaryngol* 2013; 270: 1075-1083.
- 37) MACHTAY M, PERCH S, MARKIEWICZ D, THALER E, CHALIAN A, GOLDBERG A, KLIGERMAN M, WEINSTEIN G. Combined surgery and postoperative radiotherapy for carcinoma of the base of radiotherapy for carcinoma of the base of tongue: analysis of treatment outcome and prognostic value of margin status. *Head Neck* 1997; 19: 494-499.