JCDS JOURNAL of CONTEMPORARY DENTAL SCIENCES OPEN ACCESS

Review Article

Innovations in Guided Surgery for Head and Neck Cancer Management: A Systematic Review of Advances and Perspectives in Surgical Treatment.

García Marqués A[1], Dorado Rodríguez J[2], Ouazzani Touhami M[3], Espinosa Pérz P[4], Taheri RB[5], López Quiles Martínez J[6], López Carriches C[7*]

AUTHOR'S AFFILIATIONS:

1. **Alán García Marqués**
   Degree in Dentistry, School of Dentistry.
   Universidad Complutense de Madrid. Spain
2. **Javier Dorado Rodríguez**
   Degree in Dentistry, School of Dentistry,
   Universidad Complutense de Madrid, Spain
3. **Mohamed Ouazzani Touhami**
   Degree in Dentistry, School of Dentistry,
   Universidad Complutense de Madrid, Spain
4. **Paula Espinosa Pérez**
   Degree in Dentistry, School of Dentistry,
   Universidad Complutense de Madrid, Spain
5. **Ricardo Bahram Taheri**
   Doctor of Dental Surgery, DDS, Collaborator,
   School of Dentistry, Universidad Complutense de Madrid, Spain
6. **Juan López Quiles Martínez**
   Assistant Professor, Department of Dental Clinic Specialties,
   School of Dentistry, Universidad Complutense de Madrid, Spain
7. **Carmen López Carriches**
   Associate Professor, Department of Dental Clinic Specialties,
   School of Dentistry, Universidad Complutense de Madrid, Spain
   ORCiD: https://orcid.org/0000-0003-2829-5229

ARTICLE INFO.

Received: 20 November, 2025
Accepted: 18 December, 2025

Volume: Vol-14, Issue-1, January 2026
DOI: https://doi.org/10.3329/jcds.v14i1.86318

Publisher: Sapporo Dental College, Dhaka, Bangladesh
Web: www.sdch.edu.bd
E-mail: jcds.sdc@gmail.com

Scan QR code to access your article on JCDS BanglaJOL index.

Corresponding Author*

Carmen López-Carriches
Plaza Ramón y Cajal, s/n.
28040 Madrid, Spain
E-mail: maclopez@ucm.es
ORCiD:https://orcid.org/0000-0003-2829-5229.

ABSTRACT

Background: Head and neck cancer is one of the most prevalent cancers worldwide. The low survival rate makes it essential to identify correct surgical margins. New guided surgical techniques such as TORS [robotic transoral surgery] or TOLS [transoral laser surgery] have emerged as new options for surgical resection, helping to reduce the rate of recurrence. The aim of this systematic review was to assess the surgical efficacy of resection using conventional techniques versus less invasive techniques, such as guided surgery. **Material and methods**: A systematic review was conducted following PRISMA statements. Three electronic databases were analyzed by two independent reviewers. A series of inclusion and exclusion criteria were established. **Results:** Four articles met the inclusion criteria. All studies were randomized controlled trials. The mean age of the patients was 40-60 years old. Cancer was most present in the tonsillar region [2583], with stages I [2036] and II [2097] mainly. The presence of negative margins [3637] was higher in most studies than positive ones [869]. A lower recurrence of these margins was found using guided surgery. **Conclusion:** Guided surgery is used in earlier stages of cancer, leaving a lower recurrence due to a greater intraoperative control of the surgical margins. The conventional technique supposes a more complex intraoperative management. More studies are needed to support guided surgery efficacy, but it is proposed as a good alternative to the conventional technique.

KEY WORDS: *head and neck cancer; oral squamous cell carcinoma; transoral robotic surgery; guided surgery*.

INTRODUCTION

Head and neck cancer is the sixth most prevalent cancer globally, and the survival rate is low [1]. In the past, patients with an advanced stage of the disease were the most common. However, thanks to technological advancements, the number of diagnoses in the early stages is increasing. The classic approach to this pathology consists of the application of radiotherapy or chemotherapy. Also, the resection of the primary tumor and cervical dissection of the affected lymph nodes are performed. Surgeons have considered surgical resection to be the most effective treatment. [1-4]

Currently, new surgical interventions are emerging to the concept of minimally invasive surgery. This approach provides an improvement both in the visualization and management of the surgical field. This surgical approach aims to preserve orofacial function, including swallowing, phonation, and airway conservation. [2,5]

Among the new techniques that aim at a minimally invasive approach, we can find guided surgery, such as transoral robotic surgery [TORS], transoral laser surgery [TOLS], as well as radiofrequency [RF] ablation of lymph nodes [6-9].

It is essential to address the concept of the free surgical margin. Achieving adequate surgical margins can be challenging. Following the guidelines of the National Comprehensive Cancer Network [NCCN], surgeons place the margins 1.5-2.0 cm from the primary tumor, based on the visibility of the abnormal area, as well as on palpation of the lesion [1].

Another aspect to consider when treating head and neck cancer is the reconstruction of all the defects that appear after the surgical intervention for the elimination of the tumor. Prosthetic rehabilitation or reconstructive surgical procedures are implied. These use scapular and fibula flaps for the reconstruction of maxillary defects. Surgical planning software designs that generate templates and cutting guides, achieving greater intraoperative precision [10–

12]. The distinction between a pedunculated flap and free flap for the reconstruction of these defects should be mentioned. Free flap is preferred over pedunculated flap due to the increased risk of pedicle torsion and necrosis, as well as greater damage to the donor area [16]. The aim of this systematic review was to assess the situation of minimally invasive approaches of head and neck cancer compared to traditional techniques. Also, to analyze the techniques developed for the evaluation of surgical intervention, recurrence, survival rates, and quality of life of patients diagnosed with head and neck cancer.

MATERIAL AND METHODS

A systematic review was conducted following PRISMA guidelines. The search was carried out by reviewers [AG, MO], who analyzed in parallel three electronic databases [PubMed, Cochrane, and Web of Science]. Publications until February 2, 2024, were included. The following MESH terms were used in the search: "Head and neck cancer", "Oral Squamous Cell Carcinoma", "transoral robotic surgery", "Guided surgery"; using the "AND" and "OR" operators. The research question formulated was: "Are the new guided surgical techniques [TORS and TOLS] better in quality of life, survival rate, recurrence, and ease of surgery than conventional surgical techniques in patients with head and neck cancer?" The study question followed the PICO structure: P [population] = Patients with head and neck cancer I [Intervention] = New advances and perspectives in guided surgical treatment in oral cancer C [comparison] = Comparison between guided surgical techniques and conventional ones O [outcome/outcome] = Quality of life/survival rate, recurrence and ease of life.

The inclusion criteria were randomized clinical trials and systematic reviews in English, describing human patients with a confirmed diagnosis of head and neck cancer, and comparing TORS surgery or guided surgery with conventional surgeries.

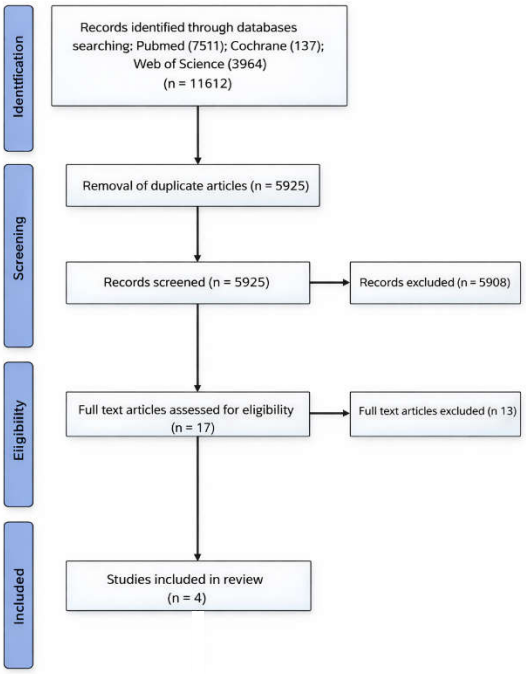

Figure 1: Flowchart

We excluded articles describing other treatments for oral cancer such as chemotherapy and radiotherapy or cancers other than head and neck. In addition, we excluded studies without conclusive data or that do not have a sufficient sample size. Also we excluded non-peer-reviewed publications, studies with unclear results not related to the PICO question, and retrospective studies.

RESULTS

A total of 11612 articles were identified in the initial search [Figure 1]. Duplicated articles were excluded before the articles were screened following PRISMA guidelines. Articles that did not meet the inclusion criteria were discarded, selecting those that were of greater interest to answer our PICO question. Eligibility was assessed in a total of 17 articles. Only 4 articles were included in the study.

Regarding the information recorded in the articles, the names of the authors and the year of publication, the number of patients and their mean age, the follow-up in months, the intra-postoperative time, the postoperative and intraoperative complications, the cost of surgery, the recurrence and mortality rate, and patient satisfaction were obtained.

Table 1: Characteristics of the included studies

Author (year)	Design	Group GS/US	Number of patients	Age, M (SD)	Gender
Nguyen AT et al. (2020)	RCT	GS vs US	4071	58,8 +-9,6	NR
		GS	1746	59,2 (9,2)	
		US	2325	58,5 (9,9)	
Schalch et al. (2021)	RCT	GS vs US	NR	46,4	
		GS	NR	47,6	
		US	NR	45,2	Female
Durham JM et al. (2023)	RCT	GS	443	61,5 (13,3)	Female: 179 Male: 264
Zwakenberg MA et al. (2023)	RCT	US	113	69 (10,5)	Female: 14 Male: 99

GS = guided surgery; US = unguided surgery; NR = does not refer; RCT=Randomized Control Trial

All four trials were randomized clinical trials. There are 3 groups for comparison: cancers that have been removed by guided surgery, another group where the removal has not been by guided surgery, and finally, a group with both patients.

The study conducted by Zwakenberg MA. et al. [2023] had the fewest patients, with only 113 participants. In contrast, the study carried out by Nguyen AT et al. [2020] had the highest number of patients, with 4071 participants. These findings have been used to verify the number of patients in each study.

The final aspect that this table evaluates is the average age of the subjects. Both the study by Nguyen AT et al. [2023] and Schalch et al. [2021] report an average age between 40 and 50 years. However, in the studies by Durham JS. et al. [2020] and Zwakenberg MA. et al. [2023], the average age of the patients was 60 years.

Table 2 compares aspects such as anatomical location, staging, tobacco and alcohol intake. Also, complications, margins, local recurrence, and mortality are recorded.

According to a study conducted by Nguyen AT et al. [2020], cancer is more commonly found in the base of the tongue, tonsils, and related areas. The second location is the most frequently affected. *Schalch et al. [2021]* found that the most predominant anatomical area was the thyroid.

The stage parameter was analyzed by the studies of Nguyen AT et al. [2020], Schalch et al. [2021], and *Zwakenberg MA* et al. [2023].

Nguyen et al. described the resection of cancers in stages T1, T2, T3, and T4. It should be noted that in this study, the predominant stages and the stages in which most surgical resections are performed are stage I [1839] and II [1949], although in proportion to unguided surgery, it is lower than this.

Table 2: Data extracted and collected.

Author (year)	Group (GS/US)	Anatomical location			Staging				Tobacco and/or alcohol	Complications	Margins		Local recurrence	Mortality
		Tongue Base	Tonsil	Other	T1	S2	S3	S4			Negative	Positive		
Nguyen AT et al. (2020)	GS vs US	1238	2583	250	1839	1949	214	69	NR	NR	3382	698	NR	NR
	GS	598	1053	95	773	866	85	22			1528	218		
	US	640	1530	155	1066	1083	129	47			1854	471		
Schalch et al. (2021)	GS vs US	NR	NR	10		NR		NR	NR	4	NR	NR	NR	NR
	GS	NR	NR	5						2				
	US	NR	NR	5						2				
Durham JM et al. (2023)	GS		NR		115	146	NR	NR	289 (T)	NR	210	133	45	79
Zwakenber MA et al. (2023)	GS		NR		82	2	NR	NR	89 (T); 72 (A)	NR	45	47	46	NR

GS = guided surgery; US = unguided surgery; NR = does not refer

Schalch et al. [2021] and Zwakenberg MA et al. [2023], performed surgical resections only in stage I and II. The presence of tobacco and alcohol was only found in the articles by *Durham JS et al. [2020] [289 smokers] and Zwakenberg MA. et al*. [2023] [89 smokers and 72 alcohol consumers]

Finally, the presence of positive and negative surgical margins and the relationship with recurrence were assessed. *Nguyen AT et al. [2020] [1528], Durham JS et al. [2020] [210] and Zwakenberg MA. et al. [2023] [45]* found an increased presence of negative than positive margins in the guided surgical technique. These positive margins are related to a recurrence in cancer, being higher in proportion in the study by *Zwakenberg MA. et al. [2023],* compared to that of *Durham JS et al. [2020].*

DISCUSSION

The articles analyzed in this systematic review compare complications, margin presence, local recurrence, and mortality of patients based on whether they underwent guided or unguided surgery. Guided surgery is a constantly evolving technique that advances as new technologies develop.

It is crucial to evaluate and compare the efficacy of these therapeutic options with conventional treatment objectively and prospectively. [6] In this context, we can refer to the term DAOH ["Days alive and out of hospital"], which provides information about the efficiency, morbidity, and quality of the treatment received. [4,7]

Among the advantages of these interventions are scar reduction, fewer operative complications, functional preservation, reduction of lymph node volume, and a lower recurrence rate. However, the high cost of the procedure must be considered. Also, the anatomical limitations of the technique such as tumor size and location. [13]. This type of innovation in the technique is associated with a reduction in operative time, less hospitalization, and a better quality of life after surgery [5,14]. However, there is not only an improvement on the surgical technique, but also on the postoperative evaluation and follow-up of surgical results [5].

It has been observed that genetically altered cells are usually scattered around the mucosa of the primary tumor. These cells also reach mucosa which is clinically classified as healthy. Therefore, there would be a false belief of an unaffected margin. Affected margins are known to be associated with increased local recurrence [second primary] and decreased overall survival. Classically, tintion of the lesion with toluidine blue or iodine have been used for the detection of affected margins. Iodine tincture has been found to be particularly effective because it correctly stains healthy non-keratinized epithelium. Greater difficulty is observed when staining healthy keratinized epithelium [gum, hard palate] and in areas with abnormalities or dysplasias. We can also find another disadvantage in this classic method of evaluating surgical margins, such as the possibility of inducing adverse reactions [1].

Nowadays, there has been a technological development that allows an adequate margin delimitation, both during and after surgical procedures. Narrow Band Imaging [NBI] is an intraoperative technique that uses an optical filter with blue [415 nm] and green [540 nm] light that penetrates the superficial mucosal and submucosal layers, highlighting superficial vascular structures and thus being able to more easily identify premalignant lesions and ensure correct margins.

Post-treatment fluorescence allows direct visualization of the abnormal area by tissue autofluorescence, observing a greenish color of all healthy tissue and a darker color [with a lack of fluorescence] of all tissue that is suffering some type of abnormality. Therefore, this tissue is necessary to be included in the resection of the primary tumor [1,4,13,15,16].

This can cause some reluctance in their use, both on the part of the professional and the patient in aspects such as safety, efficacy and costs associated with these technologies. It has been noted that in these studied articles there is not a great difference between the presence of positive and negative surgical margins in both guided and conventional surgery. In addition, the number of patients with complications are similar between these two surgical techniques. This shows that guided surgery techniques have a reliability and predictability similar to that of conventional surgeries.

Within the limitations of this review, we found a limited number of studies that compare these techniques using common variables. Future studies must standardize the variables to strengthen the validity and generalizability of the findings. In addition, more studies are needed to assess long-term outcomes, such as patient recurrence, survival, and quality of life.

CONCLUSION

After conducting a thorough analysis of the research on guided surgery for the treatment of oral cancer, it can be inferred that there

is a limited number of scientific studies that examine the use of guided technology for surgical resection of cancerous tissue. Comparing the findings is challenging since each study discusses a specific type of cancer with a specific technique.

This innovative surgical technique has been observed to be effective in earlier stages of cancer. It provides greater intraoperative control of the surgical margins which results in a lower recurrence rate than with more conventional techniques. Although more evidence is needed to support its effectiveness, this type of surgery is proposed as a good alternative to conventional techniques. It can help reduce the recurrence and ultimately the mortality rate of this prevalent disease worldwide.

CONFLICT OF INTEREST: The authors declare no conflict of interest.

FUNDING: This research received no external funding.

DATA AVAILABILITY STATEMENT: The data presented in this study are available on reasonable request from the corresponding author

REFERENCES:

1. Ikeda Y, Suzuki T, Saitou H, Ogane S, Hashimoto K, Takano N, et al. Usefulness of fluorescence visualization-guided surgery for early-stage tongue squamous cell carcinoma compared to iodine vital staining. Int J Clin Oncol. 2020 Sep 1; 25[9]:1604-11. https://doi.org/10.1007/s10147-020-01710-0 PMid:32451767 PMCid:PMC7441058
2. Nishimura G, Sano D, Arai Y, Hatano T, Takahashi H, Tanabe T, et al. A prospective clinical trial of the second-look procedure for transoral surgery in patients with T1 and T2 laryngeal, oropharyngeal, and hypopharyngeal cancer. Cancer Med. 2019 Dec 1; 8[17]:7197-206. https://doi.org/10.1002/cam4.2588 PMid:31595716 PMCid:PMC6885886
3. Zhao J, Wang J, Cheng R, Qin J, Ai Z, Sun H, et al. Safety and effectiveness of carbon nanoparticles suspension-guided lymph node dissection during thyroidectomy in patients with thyroid papillary cancer: a prospective, multicenter, randomized, blank-controlled trial. Front Endocrinol [Lausanne]. 2023;14. https://doi.org/10.3389/fendo.2023.1251820 PMid:38260138 PMCid:PMC10801185
4. Larsen MHH, Scott SI, Kehlet H, von Buchwald C. Days alive and out of hospital a validated patient-centred outcome to be used for patients undergoing transoral robotic surgery: protocol and perspectives. Acta Otolaryngol. 2021; 141[1]:95-8. https://doi.org/10.1080/00016489.2020.1814964 PMid:33107363
5. Krishnan G, van den Berg NS, Nishio N, Kapoor S, Pei J, Freeman L, et al. Fluorescent Molecular Imaging Can Improve Intraoperative Sentinel Margin Detection in Oral Squamous Cell Carcinoma. Journal of Nuclear Medicine. 2022 Aug 1; 63[8]:1162-8. https://doi.org/10.2967/jnumed.121.262235 PMid:35027369
6. Hassid S, Krug B, Deheneffe S, Daisne JF, Delahaut G, Lawson G, et al. Treatment of supraglottic squamous cell carcinoma with advanced technologies: observational prospective evaluation of oncological outcomes, functional outcomes, quality of life and cost-effectiveness [SUPRA-QoL]. BMC Cancer. 2023 Dec 1; 23[1]. https://doi.org/10.1186/s12885-023-10953-9 PMid:37264321
7. Ferris RL, Flamand Y, Holsinger FC, Weinstein GS, Quon H, Mehra R, et al. A novel surgeon credentialing and quality assurance process using transoral surgery for oropharyngeal cancer in ECOG-ACRIN Cancer Research Group Trial E3311. Oral Oncol. 2020 Nov 1;110. https://doi.org/10.1016/j.oraloncology.2020.104797 PMid:32679405 PMCid:PMC7771718
8. Schalch MS, Costa ACN, de Souza RP, Guerra FLB, Guerreiro R, De Cicco R. Radiofrequency ablation of thyroid nodules: prospective cost-effectiveness analysis in comparison to conventional thyroidectomy. Arch Endocrinol Metab. 2021; 65[6]:752-7. https://doi.org/10.20945/2359-3997000000411 PMid:34762781 PMCid:PMC10065391
9. de Freitas RMC, Miazaki AP, Tsunemi MH, de Araujo Filho VJF, Marui S, Danilovic DLS, et al. Laser Ablation of Benign Thyroid Nodules: A Prospective Pilot Study With a Preliminary Analysis of the Employed Energy. Lasers Surg Med. 2020 Apr 1; 52[4]:323-32. https://doi.org/10.1002/lsm.23144 PMid:31347193
10. Alwadeai MS, Al-aroomy LA, Shindy MI, Amin AAW, Zedan MH. Aesthetic reconstruction of onco-surgical maxillary defects using free scapular flap with and without CAD/CAM customized osteotomy guide. BMC Surg. 2022 Dec 1; 22[1]. https://doi.org/10.1186/s12893-022-01811-9 PMid:36261822 PMCid:PMC9583586
11. Al-Sabahi ME, Jamali OM, Shindy MI, Moussa BG, Amin AAW, Zedan MH. Aesthetic Reconstruction of Onco-surgical Mandibular Defects Using Free Fibular Flap with and without CAD/CAM Customized Osteotomy Guide: A Randomized Controlled Clinical Trial. BMC Cancer. 2022 Dec 1; 22[1]. https://doi.org/10.1186/s12885-022-10322-y PMid:36460978 PMCid:PMC9717507
12. Xu J, Lai F, Liu Y, Tan Z, Zheng C, Wang J, et al. Novel computer-aided reconstruction of soft tissue defects following resection of oral and oropharyngeal squamous cell carcinoma. World J Surg Oncol. 2022 Jun 13; 20[1]:196. https://doi.org/10.1186/s12957-022-02654-7 PMid:35698194 PMCid:PMC9195432
13. Christensen A, Juhl K, Kiss K, Lelkaitis G, Charabi BW, Mortensen J, et al. Near-infrared fluorescence imaging improves the nodal yield in neck dissection in oral cavity cancer - A randomized study. European Journal of Surgical Oncology. 2019 Nov 1; 45[11]:2151-8. https://doi.org/10.1016/j.ejso.2019.06.039 PMid:31307814
14. Nguyen AT, Luu M, Mallen-St Clair J, Mita AC, Scher KS, Lu DJ, et al. Comparison of Survival after Transoral Robotic Surgery vs Nonrobotic Surgery in Patients with Early-Stage Oropharyngeal Squamous Cell Carcinoma. JAMA Oncol. 2020 Oct 1; 6[10]:1555-62. https://doi.org/10.1001/jamaoncol.2020.3172 PMid:32816023 PMCid:PMC7441465
15. Durham JS, Brasher P, Anderson DW, Yoo J, Hart R, Dort JC, et al. Effect of Fluorescence Visualization-Guided Surgery on Local Recurrence of Oral Squamous Cell Carcinoma: A Randomized Clinical Trial. JAMA Otolaryngol Head Neck Surg. 2020 Dec 1; 146[12]:1149-55. https://doi.org/10.1001/jamaoto.2020.3147 PMid:33034628 PMCid:PMC7545352
16. Zwakenberg MA, Westra JM, Halmos GB, Wedman J, van der Laan BFAM, Plaat BEC. Narrow-Band Imaging in Transoral Laser Surgery for Early Glottic Cancer: A Randomized Controlled Trial. Otolaryngology - Head and Neck Surgery [United States]. 2023 Sep 1; 169[3]:606-14. https://doi.org/10.1002/ohn.307 PMid:36821814

How to cite:
García Marqués A, Dorado Rodríguez J, Ouazzani Touhami M, Espinosa Pérz P, Taheri RB, López Quiles Martínez J, López Carriches C. Innovations in Guided Surgery for Head and Neck Cancer Management: A Systematic Review of Advances and Perspectives in Surgical Treatment. J. Contemp. Dent. Sci. [Internet]. [cited 2026 Feb. 10];14(1):23-26. Available from: https://www.banglajol.info/index.php/JCDS/article/view/86318

JCDS -ISSN: 2305-9664