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Navigating The Pros And Cons Of Robotic Assistance In Oral & Maxillofacial Surgeries: Boon Or Bane

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Abstract:
Robotics has emerged as a transformative technology in oral surgery, offering unprecedented precision and enhancing surgical outcomes. This article provides an overview of the applications, advancements, and challenges of robotics in the field of oral and maxillofacial surgery. Key applications include dental implant placement, orthognathic surgery, tumor resection, and nerve repair. The integration of robotics allows for precise pre-operative planning through advanced imaging and simulation, thereby minimizing risks and improving patient safety. Despite its benefits, challenges such as cost, training requirements, and surgical workflow integration remain. Ongoing research focuses on enhancing haptic feedback, miniaturizing robotic tools, and integrating artificial intelligence to further refine surgical techniques. Looking forward, robotics holds promise in revolutionizing oral surgery by pushing the boundaries of surgical precision and patient care.

Keywords:*Head and neck, Maxillofacial surgery, Oral Surgical procedures, Robotic surgery, Robot-assisted dental implant surgery, Static guided surgery, Dynamic guided surgery, Maxillary repositioning, Orthognathic surgery, Accuracy*

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I. Introduction:

For decades, robotics and surgery evolved autonomously.[1]The term "robot" originated from the Czech word "Robota," meaning "labor" or "drudgery," coined by Czech writer Karel Čapek in 1920. In 1967, Masahiro Mori defined robots as "flexible machines" possessing characteristics like mobility, intelligence, and versatility.[2]According to the American National Standards Institute; robots are programmable mechanical devices capable of autonomous operations and mobility tasks.[3]Medical robots are categorized as macrorobots, microrobots, and bio-robots.[4] Joseph Engelberger, recognized as the Father of Robotics, founded Unimation Corporation in 1958, the world's first robot-manufacturing factory, which marked the official start of the industrialization of robots.[5] In 1978, Unimation developed a Programmable Universal Machine for Assembly, representing a significant milestone in the development of international industrial robotics. In the late 1980s and early 1990s, endoscopic techniques flourished but faced limitations. The potential of telerobotics in minimally invasive surgery became evident, although the safe integration of robots and surgery via telemanipulation for surgical innovation was achieved only recently.[6] As technology has advanced, robotic-assisted surgery has shown numerous advantages over conventional techniques, including more precision, efficiency, minimal invasiveness, and safety, making it a research hotspot and cutting-edge trend.[7] Advances in digital imaging, 3D printing, and new restorative materials have transformed dentistry. Robotics is the next frontier, promising superior precision, reduced human error, and improved patient outcomes.[8] The successful application of medical robots, such as the da Vinci Surgical System, has spurred enthusiasm for robotics in dentistry.[9] Applications include the Yomi Dental Robot for dental implants, microrobots in endodontics, and potential use in maxillofacial surgery.[10]Despite the benefits, the adoption of robotics in dentistry faces challenges such as cost, learning curves, and the need for further research.

Dental schools like Boston University and New York University College of Dentistry are integrating robotics into their curricula, preparing future practitioners to effectively utilize these technologies.[11] While challenges may slow widespread adoption, continued innovation is expected to drive broader integration in dental practices worldwide. The future of dental robotics holds promise beyond implant surgery, potentially impacting orthognathic surgery, endodontics, prosthetics, and more. Robotics in oral surgery has the potential to redefine treatment standards and improve patient outcomes as technology evolves and research expands.Overall, robotic surgery in head and neck oncology demonstrates significant potential to improve surgical outcomes, reduce morbidity, and enhance patients' quality of life by preserving critical functions such as speech and swallowing.[12]

II. Discussion:

In the ever-evolving landscape of healthcare technology, robotic assistance has emerged as a promising tool in the field of oral and maxillofacial surgeries. This innovative approach offers a spectrum of potential benefits, yet also presents challenges and considerations that merit careful examination. By exploring both the advantages and drawbacks of integrating robotic systems into surgical practices, dentists and oral surgeons can discern whether they represent a transformative boon or a potential bane for the future of patient care.[13]Orthognathic surgery is pivotal in correcting dentofacial deformities, where achieving precise outcomes is crucial for patient satisfaction. Traditional methods using intermediate splints for maxillary repositioning have historically been fraught with challenges such as inaccuracies and complex laboratory procedures.[14] In response, newer techniques like intraoperative navigation, template-based surgery, and patient-specific implants have emerged to enhance precision without relying on mandibular autorotation.[15]These advancements mitigate intraoperative errors and streamline procedures by eliminating labor-intensive preoperative preparations.[16]

Despite progress in navigation and implant technologies, achieving precise maxillary positioning remains complex. Template-based surgery and patient-specific implants offer promising accuracy but require extensive planning and may limit intraoperative flexibility. Medical robotics present a transformative opportunity in orthognathic surgery by focusing on osteotomy and bone segment repositioning, enabling real-time adjustments based on intraoperative data.This not only enhances surgical precision but also facilitates minimally invasive techniques, accelerating recovery times.[17] Research into robotic systems that integrate surgical navigation for maxillary repositioning shows promising benefits that require validation through experimental studies.[18] One study evaluated the feasibility and accuracy of robot-assisted maxillary repositioning through postoperative Computed Tomography analysis, highlighting promising outcomes while acknowledging existing challenges.[19]Surgical navigation combined with robotic assistance is showing promising results in improving the accuracy and efficacy of orthognathic surgeries, particularly in maxillary repositioning.[20] This approach integrates real-time tracking of anatomical structures and precise execution of surgical plans, leading to minimal deviations from the intended postoperative outcomes.[21] Jeong Joon Han et.al evaluated the effectiveness of a system where a robot arm, guided by surgical navigation, maintained the maxilla in the desired position during orthognathic surgery.Results indicated minimal displacements—0.42 mm medio-laterally, 0.37 mm antero-posteriorly, and 0.38 mm supero-inferiorly—compared to the surgical plan.[22] These outcomes are comparable to those achieved with other advanced surgical techniques like template-based surgery and patient-specific implants. Traditionally, methods such as interocclusal splints and customized guides have been used, but they pose challenges like inflexibility during surgery and potential inaccuracies due to preparation errors.[23]

In contrast, the robotic system offers flexibility during surgery, allowing adjustments to the surgical plan in real-time, which is crucial for adapting to unforeseen circumstances.[24] However, the integration of robotic technology in orthognathic surgery, also presents challenges. Fully autonomous surgeries, while technically feasible, require robust safety measures to prevent malfunctions. Additionally, the lack of tactile feedback in robotic arms may hinder their ability to detect and address bony interferences accurately, potentially prolonging surgical procedures.[25] To assess surgical outcomes, 3D Computed Tomography scans are commonly used despite inherent limitations such as differences between reconstructed models and actual anatomy. Techniques like optical scanning and dental markers are employed to minimize these errors and ensure accurate evaluation of surgical results.[26] The combination of robotic assistance and surgical navigation holds promise for enhancing orthognathic surgeries, it necessitates addressing cost considerations, space requirements, and technological refinements for clinical applicability.[27] Future advancements should focus on improving safety features, enhancing tactile perception in robotic systems, and optimizing integration into routine surgical practices.The broader adoption of robotic surgery in maxillofacial surgery, including applications for head and neck tumours, faces obstacles such as extended surgical durations and specific technical demands.[28]Addressing these issues necessitates ongoing research and technological refinements to optimize robotic surgery across diverse head and neck procedures.[29]Critical aspects requiring further investigation before robotic surgery becomes a standard treatment include long-term efficacy assessments, cost-effectiveness analyses, and resolving unique field challenges.[30]Future advancements in robotic surgery entail developing specialized instruments for head and neck procedures, miniaturizing components for precise manoeuvres, integrating haptic feedback for surgical dexterity, enabling multi-surgeon capabilities, and designing flexible multiportaccess devices.[31]Continued innovation promises to expand robotic technology's application in enhancing surgical precision, patient outcomes, and overall standards of care in head and neck surgery. Virtual surgical planning, which enhances robotic system precision and efficiency, holds potential for reducing surgical duration and improving outcomes in reconstructive procedures. Integrating robotic surgery with Virtual Surgical Planning represents a promising direction for advancing robotic-assisted procedures in head and neck surgery.[32]Transoral robotic surgery has demonstrated significant advantages over traditional methods, particularly in reducing complications and postoperative bleeding.[33] Lee et al. reported that Transoral Robotic Surgery resulted in shorter operation times, faster recovery of swallowing function, and reduced hospital stays compared to conventional approaches.[34]While procedures such as submandibular gland excisions may still require transcervical approaches, Transoral Robotic Surgery offers aesthetic benefits through techniques like the retroauricular or modified facelift incision, resulting in minimal visible scarring.[35]Robotic systems equipped with neurostimulators provide a technical advantage by emitting warnings when approaching nerves, eliminating the need for frequent instrument changes required in open surgeries.[36]Robotic approaches in neck dissections, such as the transaxillary method introduced by Kang et al., have demonstrated advantages over traditional open surgeries by minimizing visible scarring and better preserving muscle function.[37] However, challenges in accessing deep neck levels have led to the development of alternative techniques like the retroauricular or facelift approach, pioneered by Lee et al.[38]Despite longer operative times associated with robotic neck dissections, outcomes related to intraoperative bleeding, nodal recurrence, postoperative drainage, hospital stays, and patient satisfaction with postoperative aesthetics remain comparable to those of traditional methods. These advancements underscore the evolving role of robotics in enhancing surgical precision and patient outcomesacross various procedures in head and neck surgery.[39] In the realm of cleft palate surgeries, robotic techniques are still evolving. Nadjmi's research indicates that while muscle sling reconstruction using robotics may take longer than traditional methods (average of 9.5 months), it results in shorter hospital stays and faster functional recovery. This is attributed to the precise dissection capabilities of robotic systems, which minimize damage to muscle vascularization and innervation.[40]These cancers are globally significant with high incidence rates and mortality statistics. Surgery remains crucial for treating many head and neck cancers, especially when tumors near the larynx pose challenges for traditional surgical methods.[41] Robotic surgery offers a minimally invasive option for precise tumor removal, leading to improved postoperative outcomes in speech and swallowing functions. The technology continues to advance, broadening its applications in managing head and neck neoplasms.[42]Initially demonstrated in preclinical experiments, robot-assisted surgery for conditions like vallecular cysts began with successful procedures by McLeod and Melder in 2005.[43] Subsequent advancements, such as robot-assisted resections of base of tongue neoplasms by O'Malley and colleagues, and radical tonsillectomies by Weinstein and team, have further expanded the scope of Transoral Robotic Surgery.[44]It has been extensively studied across various neoplasms including squamous cell carcinoma, mucoepidermoid carcinoma, malignant melanoma, synoviosarcoma, adenoid cystic carcinoma, pleomorphic adenoma, lipoma, and neurilemmoma.[45] Research consistently demonstrates that Transoral Robotic Surgery for primary or recurrent neoplasms in the oral cavity, oropharynx, nasopharynx, and laryngopharynx results in superior functional recovery, higher rates of negative margins, and improved survival outcomes compared to traditional open surgery or radiochemical therapy.[46] Additionally, Transoral Robotic Surgery is associated with reduced risks of complications such as hemorrhage and dependence on gastrostomy or tracheostomytubes.While Transoral Robotic Surgery shows great promise, challenges remain, as reported by Blanco et al. who noted instances where Transoral Robotic Surgery for recurrent oropharyngeal squamous cell carcinoma led to postoperative metastasis in some patients.[47] The technology has also proven effective in detecting and diagnosing unknown primary tumors, particularly in Human Papilloma Virus positive patients, surpassing traditional diagnostic methods like Computed Tomography scans, positron emission tomography scans, and directed biopsies. Blanco et al. reported instances where Transoral Robotic Surgery for recurrent oropharyngeal squamous cell carcinoma resulted in regional or distant metastasis postoperatively in three out of four patients, highlighting significant challenges and outcomes that require careful consideration.[48] Despite these challenges, Transoral Robotic Surgery has shown effectiveness in detecting and diagnosing unknown primary tumors, particularly in Human Papilloma Virus positive patients, outperforming conventional methods such as computed tomography, positron-emission tomography, and directed biopsies.[49]The influence of Human Papilloma Virus status on prognosis in oropharyngeal cancer remains varied in research findings. Some studies suggest that Transoral Robotic Surgery can achieve outcomes comparable to Human Papilloma Virus negative patients in terms of resection margins and survival rates, while others indicate higher disease-free survival rates in Human Papilloma positive patients.[50]Postoperative quality of life assessments have indicated temporary declines in swallowing and speech functions 3–6 months post Transoral Robotic Surgery, with recovery to preoperative levels typically occurring within a year.[51] Robotic surgery offers several advantages including precise dissection using laser instruments, potentially reducing hemorrhage, intraoperative pharyngotomy, postoperative pain, and operation times compared to traditional electrocautery methods. However, the compact nature of the parapharyngeal space, which houses critical structures like the internal carotid artery andcranial nerves IX, X, and XI, presents challenges requiring meticulous surgical planning and technique adaptation in robotic approaches.[52]Continued research is essential to refine techniques, optimize patient selection based on Human Papilloma Virus status, and enhance postoperative outcomes and quality of life with Transoral Robotic Surgery.[53] Innovations in robotic surgery have demonstrated significant advancements in treating head and neck neoplasms.[54] Studies have shown benefits such as shorter hospital stays, rapid functional recovery, and reduced complications across various tumor types including squamous cell carcinoma, lipoma, and adenoid cystic carcinoma.[55]Challenges persist, as highlighted by Chan et al. in robot-assisted surgery for pleomorphic adenoma, due to limitations in tactile feedback and instrument handling.[56] Advancements in thyroid and mediastinal parathyroid surgeries, such as transaxillary robotic resections introduced by Bodner et al., have established minimally invasive and safe procedures.[57]Despite requiring longer operative times and hospital stays compared to traditional methods, robotic retroauricular thyroidectomy for papillary thyroid carcinoma has demonstrated feasibility and safety, reflecting ongoing progress in the field. Recent developments have also shown effectiveness in excising lingual thyroglossal duct cysts using either transoral or retroauricular approaches, minimizing complications and recurrence compared to transcervical approaches.[58] Robotic systems enhance surgical precision through enhanced three-dimensional visualization and magnification, reducing damage to surrounding tissues, intraoperative bleeding, and infection risks. For salivary gland tumors, robotic resections via retroauricular or modified face-lift approaches offer curative effects with minimal scarring, presenting more appealing options to patients compared to traditional transcervical approaches.[59] Studies by Yang et al. have suggested that robotic gland-preserving surgery may reduce intraoperative hemorrhage risk, positive margin rates, and postoperative nerve deficits compared to conventional methods,despite longer postoperative hospitalization and drainage durations due to the complexity of flap management.[60]Additionally, robotic surgery has been successfully applied for oropharyngeal minor salivary gland tumors, parotid gland tumors, and sublingual gland ranulas. Multiple studies have reported favorable outcomes, including excellent cosmetic results, minimal neurovascular damage, low positive margin rates, and rapid functional recovery, further underscoring the benefits of robotic technology in managing salivary gland pathologies.Neck dissection followed by head and neck tumor removal is always necessary to reduce locoregional recurrence.[61]Kang et al. pioneered the use of robotic surgical systems in radical neck dissection via a transaxillary approach for treating thyroid carcinoma, aiming to minimize visible scars and muscle deformities while enhancing deep and precise dissections.[62]However, this method faced challenges in completely dissecting level I regions. Subsequent advancements involved robot-assisted radical or selective neck dissections using retroauricular or modified face-lift approaches, addressing these limitations. Studies comparing robot-assisted neck dissection with traditional open surgery found similar outcomes in terms of intraoperative bleeding, lymph node retrieval, drainage volume, hospitalization duration, and complications.[63] Notably, patients undergoing Radical and neck dissection reported higher satisfaction with postoperative aesthetics. Additionally, research by Kim et al. and Tae et al. suggested potential advantages of Radical and neck dissection over conventional surgery, including lower risks of lymphedema and lymph node recurrence.[64] In post-ablative defect reconstruction, Genden et al. first utilized robotic systems for complex mucosal and flap procedures, demonstrating benefits such as shorter operative times, improved functional recovery, and enhanced aesthetic outcomes compared to traditional methods.[65]Further studies explored various flap techniques with successful outcomes, highlighting the precision and efficacy of robotic systems in reconstructive surgery. In the realm of obstructive sleep apnea syndrome, robotic surgery, particularly Transoral Robotic Surgery, emerged as a viable option for procedures like base of tongue resection, tonsillectomy, and supraglottoplasty.[66] Studies indicated that Transoral Robotic Surgery could achieve similar therapeutic efficacy to conventional surgeries but with reduced postoperative pain, shorter hospital stays, and lower rates of complications like dysphagia. The success rates of Transoral Robotic Surgery varied but generally showed significant improvements in Obstructive Sleep Apnoea Syndrome symptoms postoperatively.Overall, robotic surgical techniques continue to advance in treating various head and neck conditions, offering precise interventions with minimal morbidity and favorable functional outcomes.

III. Future Directions AndResearch Opportunities:

The future of robotics in oral surgery holds promise for further advancements. Research continues to explore applications in oral surgery, endodontics, prosthetics, and other specialized areas within dentistry, aiming to refine technologies, expand their accessibilityandare needed to address specific challenges and optimize outcomes across different procedures and patient populations.[67]

IV. Conclusion:

The integration of robotics into oral surgery presents a dual-edged prospect—offering substantial benefits while posing notable challenges. The precision and enhanced outcomes facilitated by robotics in procedures such as dental implant placement, orthognathic surgery, tumor resection, and nerve repair are undeniable. These advancements allow for meticulous pre-operative planning through advanced imaging and simulation, ultimately reducing risks and improving patient safety. However, challenges such as the high initial costs, extensive training requirements for surgeons and support staff, and the integration of robotic systems into existing surgical workflows must be carefully navigated. Overcoming these hurdles is crucial for broader adoption and realizing the full potential of robotics in oral surgery. Looking forward, ongoing research efforts aimed at enhancing haptic feedback, miniaturizing robotic tools, and integrating artificial intelligence hold promise for further refining surgical techniques and expanding the scope of robotic applications in oral surgery. Robotics in oral surgery represents a transformative boon by pushing the boundaries of surgical precision and patient care, its full realization as a universally accessible and seamlessly integrated technology remains a work in progress, demanding continued innovation and adaptation in the field.

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References

[1] Mouret P. How I Developed Laparoscopic Cholecystectomy. Ann Acad Med Singapore. 1996; 25 (5): 744–747.
[2] Liu Hh, Li Lj, Shi B, Xu Cw, Luo E. Robotic Surgical Systems In Maxillofacial Surgery: A Review. Int J Oral Sci. 2017; 9(2):63–73.
[3] Dean Nr, Rosenthal El, Carroll Wr Et Al. Robotic-Assisted Surgery For Primary Or Recurrent Oropharyngeal Carcinoma. Arch Otolaryngol Head Neck Surg. 2010; 136 (4): 380–384.
[4] Kwoh Ys, Hou J, Jonckheere Ea Et Al. A Robot With Improved Absolute Positioning Accuracy For Ct Guided Stereotactic Brain Surgery. Ieee Trans Biomed Eng. 1988; 35(2): 153–160.
[5] Talamini M, Campbell K, Stanfield C. Robotic Gastrointestinal Surgery: Early Experience And System Description. J Laparoendosc Adv Surg Tech A. 2002; 12 (4): 225–232.
[6] Bodner J, Prommegger R, Profanter C, Et Al. Thoracoscopic Resection Of Mediastinal Parathyroids: Current Status And Future Perspectives. Minim Invasive Ther Allied Technol. 2004; 13(3):199–204.
[7] Haus Bm, Kambham N, Le D Et Al. Surgical Robotic Applications In Otolaryngology. Laryngoscope. 2003; 113 (7): 1139–1144.
[8] Shield Kd, Ferlay J, Jemal A Et Al. The Global Incidence Of Lip, Oral Cavity, And Pharyngeal Cancers By Subsite In 2012. Ca Cancer J. Clin. 2017; 67 (1): 51–64.
[9] Hashim D, Sartori S, Brennan P Et Al. The Role Of Oral Hygiene In Head And Neck Cancer: Results From International Head And Neck Cancer Epidemiology (Inhance) Consortium. Ann Oncol. 2016; 27 (8): 1619–1625.
[10] WarramJm, De Be, Van Dam Gm Et Al. Fluorescence Imaging To Localize Head And Neck Squamous Cell Carcinoma For Enhanced Pathological Assessment. J Pathol Clin Res. 2016; 2 (2): 104–112.
[11] Nyu Dentistry Performs First Dental Student-Led Robot-Assisted Dental Implant 12. Abe, Susumu, Et Al. "Educational Effects Using A Robot Patient Simulation System For Development Of Clinical Attitude." European Journal Of Dental Education. 2018;22(3):E327-E336.
[12] Jr Omb, Weinstein Gs, Snyder W Et Al. Transoral Robotic Surgery (Tors) For Base Of Tongue Neoplasms. Laryngoscope. 2006; 116 (8): 1465–1472.
[13] Boudreaux B, Rosenthal E, Magnuson Js Et Al. Robot-Assisted Surgery For Upper Aerodigestive Track Neoplasms. Arch Otolaryngol Head Neck Surg. 2009; 135 (4): 397–401.
[14] Genden E, Desai S, Sung Ck. Transoral Robotic Surgery For The Management Of Head And Neck Cancer: A Preliminary Experience. Head Neck. 2009; 31 (3): 283–289.
[15] Moore Ej, Olsen Kd, Kasperbauer Jl. Transoral Robotic Surgery For Oropharyngeal Squamous Cell Carcinoma: A Prospective Study Of Feasibility And Functional Outcomes. Laryngoscope. 2009; 119 (11): 2156–2164.
[16] Iseli Ta, Kulbersh Bd, Iseli Ce Et Al. Functional Outcomes After Transoral Robotic Surgery For Head And Neck Cancer. Otolaryngol Head Neck Surg. 2009; 141 (2): 166–171.
[17] Park Ym, Kim Ws, Byeon Hk Et Al. A Novel Technique For The Resection Of The Symptomatic Lingual Thyroid: Transoral Robotic Surgery. Thyroid. 2013; 23 (4): 466–471.
[18] White Hn, Moore Ej, Rosenthal El Et Al. Transoral Robotic-Assisted Surgery For Head And Neck Squamous Cell Carcinoma: One- And 2-Year Survival Analysis. Arch Otolaryngol Head Neck Surg. 2010; 136 (12): 1248–1252.
[19] Leonhardt Fd, Quon H, Abrahão M Et Al. Transoral Robotic Surgery For Oropharyngeal Carcinoma And Its Impact On Patient Reported Quality Of Life And Function. Head Neck. 2012; 34 (2): 146–154.
[20] Remacle M, Matar N, Lawson G Et Al. Combining A New Co2 Laser Wave Guide With Transoral Robotic Surgery: A Feasibility Study On Four Patients With Malignant Tumors. Eur Arch Otorhinolaryngol. 2012; 269 (7): 1833–1837.
[21] Moore Ej, Olsen Kd, Martin Ej. Concurrent Neck Dissection And Transoral Robotic Surgery. Laryngoscope. 2011; 121 (3): 541–544.
[22] Sinclair Cf, MccollochNl, Carroll Wr Et Al. Patient-Perceived And Objective Functional Outcomes Following Transoral Robotic Surgery For Early Oropharyngeal Carcinoma. Arch Otolaryngol Head Neck Surg. 2011; 137 (11): 1112–1116.
[23] Aubry K, Yachine M, Perez Af Et Al. Transoral Robotic Surgery For Head And Neck Cancer: A Series Of 17 Cases. Eur Ann Otorhinolaryngol Head Neck Dis. 2011; 128 (6): 290–296.
[24] Olsen Sm, Moore Ej, Koch Ca Et Al. Transoral Robotic Surgery For Supraglottic Squamous Cell Carcinoma. Am J Otolaryngol. 2012; 33 (4): 379–384.
[25] Vergez S, Lallemant B, Ceruse P Et Al. Initial Multi-Institutional Experience With Transoral Robotic Surgery. Otolaryngol Head Neck Surg. 2012; 147 (3): 475–481.

[26] Moore Ej, Olsen Sm, Laborde Rr Et Al. Long-Term Functional And Oncologic Results Of Transoral Robotic Surgery For Oropharyngeal Squamous Cell Carcinoma. Mayo Clin Proc. 2012; 87 (87): 219–225.
[27] Hurtuk Am, Marcinow A, Agrawal A Et Al. Quality-Of-Life Outcomes In Transoral Robotic Surgery. Otolaryngol Head Neck Surg. 2012; 146 (1): 68–73.
[28] Hans S, Badoual C, Gorphe P Et Al. Transoral Robotic Surgery For Head And Neck Carcinomas. Eur Arch Otorhinolaryngol. 2012; 269 (8): 1979–1984.
[29] Aubry K, Yachine M, Lerat J Et Al. Transoral Robotic Surgery For The Treatment Of Head And Neck Cancer Of Various Localizations. SurgInnov. 2011; 19 (1): 60–66.
[30] Van Abel Km, Moore Ej, Carlson Ml Et Al. Transoral Robotic Surgery Using The Thulium:Yag Laser: A Prospective Study. Arch Otolaryngol Head Neck Surg. 2012; 138(2): 158–166.
[31] Weinstein Jr Gs, O'malleyBw, Magnuson Js Et Al. Transoral Robotic Surgery: A Multicenter Study To Assess Feasibility, Safety, And Surgical Margins. Laryngoscope. 2012; 122 (8): 1701–1707.
[32] Park Ym, Kim Ws, Byeon Hk Et Al. Clinical Outcomes Of Transoral Robotic Surgery For Head And Neck Tumors. Ann OtolRhinolLaryngol. 2013; 122 (2): 73–84.
[33] Park Ym, Byeon Hk, Chung Hp Et Al. Comparison Of Treatment Outcomes After Transoral Robotic Surgery And Supraglottic Partial Laryngectomy: Our Experience With Seventeen And Seventeen Patients Respectively. Clin Otolaryngol. 2013; 38 (3): 270–274.
[34] Lee Hs, Kim Ws, Hong Hj, Et Al. Robot-Assisted Supraomohyoid Neck Dissection Via A Modified Face-Lift Or Retroauricular Approach In Early-Stage Cn0 Squamous Cell Carcinoma Of The Oral Cavity: A Comparative Study With Conventional Technique. Ann Surg Oncol. 2012; 19(12):3871–8.
[35] Park Ym, Byeon Hk, Chung Hp Et Al. Comparison Study Of Transoral Robotic Surgery And Radical Open Surgery For Hypopharyngeal Cancer. Acta Otolaryngol. 2013; 133 (6): 641–648.
[36] Oysu C, Sahin-Yilmaz A. En Bloc Resection Of Epiglottic Tumors With Transoral Robotic Approach—Preliminary Results. Int J Med Robot. 2013; 9 (4): 477–479.
[37] Park Ym, De Va, Kim Ws, Et Al. Parapharyngeal Space Surgery Via A Transoral Approach Using A Robotic Surgical System: Transoral Robotic Surgery. J Laparoendosc Adv Surg Tech. 2013; 23(3):231–6.
[38] Kim Ws, Lee Hs, Kang Sm Et Al. Feasibility Of Robot-Assisted Neck Dissections Via A Transaxillary And Retroauricular ("Tara") Approach In Head And Neck Cancer: Preliminary Results. Ann Surg Oncol. 2012; 19 (3): 1009–1017.
[39] Park Ym, Lee Wj, Yun Is Et Al. Free Flap Reconstruction After Robot-Assisted Neck Dissection Via A Modified Face-Lift Or Retroauricular Approach. Ann Surg Oncol. 2013; 20 (3): 891–898.
[40] Tsang Rk. Transoral Robotic Surgery: Development And Challenges. Robot Surg Res Rev. 2015; 2(1):1–10.
[41] Nadjmi N. Transoral Robotic Cleft Palate Surgery. Cleft Palate Craniofac J. 2015; 44: E114–E115.
[42] Richmon Jd, Quon H, Gourin Cg. The Effect Of Transoral Robotic Surgery On Short-Term Outcomes And Cost Of Care After Oropharyngeal Cancer Surgery. Laryngoscope. 2014; 124 (1): 165–171.
[43] Kasim Durmus Md, Patwa Hs, GokozanHn Et Al. Functional And Quality-Of-Life Outcomes Of Transoral Robotic Surgery For Carcinoma Of Unknown Primary. Laryngoscope. 2014; 124 (9): 2089–2095.
[44] McleodIk, Melder Pc. Da Vinci Robot-Assisted Excision Of A Vallecular Cyst: A Case Report. Ear Nose Throat J. 2005; 84 (3): 170–172.
[45] Weinstein Jr Gs, O'malleyBw, Snyder W Et Al. Transoral Robotic Surgery: Radical Tonsillectomy. Arch Otolaryngol Head Neck Surg. 2007; 133 (12): 1220–1226.
[46] Lee Hs, Kim Ws, Hong Hj Et Al. Robot-Assisted Supraomohyoid Neck Dissection Via A Modified Face-Lift Or Retroauricular Approach In Early-Stage Cn0 Squamous Cell Carcinoma Of The Oral Cavity: A Comparative Study With Conventional Technique. Ann Surg Oncol. 2012; 19 (12): 3871–3878.
[47] Wei Wi, Ho Wk. Transoral Robotic Resection Of Recurrent Nasopharyngeal Carcinoma. Laryngoscope. 2010; 120 (10): 2011–2014.
[48] Blanco Rg, Fakhry C, Ha Pk, Et Al. Transoral Robotic Surgery Experience In 44 Cases. J Laparoendosc Adv Surg Tech A. 2013; 23(11):900–7.
[49] Park Ym, Kim Ws, Byeon Hk Et Al. Oncological And Functional Outcomes Of Transoral Robotic Surgery For Oropharyngeal Cancer. Br J Oral Maxillofac Surg. 2013; 51 (5): 408–412.
[50] Wei Wi, Ho Wk. Transoral Robotic Resection Of Recurrent Nasopharyngeal Carcinoma. Laryngoscope. 2010; 120(10):2011–4.
[51] Mendelsohn Ah, Remacle M, Van Dvs Et Al. Outcomes Following Transoral Robotic Surgery: Supraglottic Laryngectomy. Laryngoscope. 2013; 123 (1): 208–214.
[52] Mehta V, Johnson P, Tassler A, Et Al. A New Paradigm For The Diagnosis And Management Of Unknown Primary Tumors Of The Head And Neck: A Role For Transoral Robotic Surgery. Laryngoscope. 2013; 123(1):315–22.
[53] Abuzeid Wm, Bradford Cr, Divi V. Transoral Robotic Biopsy Of The Tongue Base: A Novel Paradigm In The Evaluation Of Unknown Primary Tumors Of The Head And Neck. Head Neck. 2013; 35 (4): 126–130.
[54] Channir Hi, Rubek N, Nielsen Hu Et Al. Transoral Robotic Surgery For The Management Of Head And Neck Squamous Cell Carcinoma Of Unknown Primary. Acta Otolaryngol. 2015; 135 (10): 1051–1057.
[55] Kelly K, Johnson-Obaseki S, Lumingu J, Et Al. Oncologic, Functional And Surgical Outcomes Of Primary Transoral Robotic Surgery For Early Squamous Cell Cancer Of The Oropharynx: A Systematic Review. Oral Oncol. 2014; 50(8):696–703.
[56] Kasim Durmus Md, Patwa Hs, GokozanHn, Et Al. Functional And Quality-Of-Life Outcomes Of Transoral Robotic Surgery For Carcinoma Of Unknown Primary. Laryngoscope. 2014; 124(9):2089–95.
[57] Chan Jy, Tsang Rk, Eisele Dw Et Al. Transoral Robotic Surgery Of The Parapharyngeal Space: A Case Series And Systematic Review. Head Neck. 2015; 37 (2): 293–298.
[58] Bodner J, Prommegger R, Profanter C Et Al. Thoracoscopic Resection Of Mediastinal Parathyroids: Current Status And Future Perspectives. Minim Invasive Ther Allied Technol. 2004; 13 (3): 199–204.
[59] Kountakis Se, Minotti Am, Maillard A, Stiernberg Cm. Teratomas Of The Head And Neck. Am J Otolaryngol. 1994; 15(4):292–6.
[60] Brodsky Jr, Irace Al, Didas A, Watters K, Estroff Ja, Barnewolt Ce, Et Al. Teratoma Of The Neonatal Head And Neck: A 41-Year Experience. Int J PediatrOtorhinolaryngol. 2017; 97:66–71.
[61] Yang Tl, Ko Jy, Lou Pj Et Al. Gland-Preserving Robotic Surgery For Benign Submandibular Gland Tumours: A Comparison Between Robotic And Open Techniques. Br J Oral MaxillofacSurg 2014; 52 (5): 420–424.
[62] Villanueva Nl, De Almeida Jr, Sikora Ag Et Al. Transoral Robotic Surgery For The Management Of Oropharyngeal Minor Salivary Gland Tumors. Head Neck 2014; 36 (1): 28–33.

[63] Kang Sw, Lee Sh, Ryu Hr Et Al. Initial Experience With Robot-Assisted Modified Radical Neck Dissection For The Management Of Thyroid Carcinoma With Lateral Neck Node Metastasis. Surgery. 2010; 148 (6): 1214–1221.
[64] Greer Aw, Kenneth Bj, De Almeida Jr Et Al. Robot-Assisted Level Ii-Iv Neck Dissection Through A Modified Facelift Incision: Initial North American Experience. Int J Med Robot. 2014; 10 (4): 391–396.
[65] Lallemant B, Chambon G, Garrel R Et Al. Transoral Robotic Surgery For The Treatment Of T1-T2 Carcinoma Of The Larynx: Preliminary Study. Laryngoscope. 2013; 123 (10): 2485–2490.
[66] Ansarin M, Zorzi S, Massaro Ma Et Al. Transoral Robotic Surgery Vs Transoral Laser Microsurgery For Resection Of Supraglottic Cancer: A Pilot Surgery. Int J Med Robot. 2014; 10 (1): 107–112.
[67] Friedman M, Hamilton C, Samuelson Cg, Et Al. Transoral Robotic Glossectomy For The Treatment Of Obstructive Sleep Apnea-Hypopnea Syndrome. Otolaryngol Head Neck Surg. 2012; 146(5):854–62.
[68] Friedman M, Kelley K, Maley A. Robotic Glossectomy For Obstructive Sleep Apnea Technique. Oper Tech Otolayngol Head Neck Surg. 2013; 24(24):106–10.