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Review Article

A Review of the Application of Robots in Maxillofacial Surgery

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Abstract

Aim: The purpose of this study was to review new articles on the use of robotic surgery in maxillofacial surgery.

Method and Materials: For the purpose of this review study, all Medline (PubMed), Google scholar electronic resources focused on the use of robotic surgery in maxillofacial surgery in the period 1999-2021 were reviewed.

Results: Using robots in maxillofacial surgery can reduce hospitalization time, reduce intraoperative bleeding, and improve recovery for patients, although the high cost and lack of touch can be a problem.

Conclusion: The results of this review study show that the surgery robot can replace open surgical methods of maxillofacial surgery. Although it may not be generalized for use, patients may be assisted in areas where the surgeon may not be present.

Keywords: Oral and maxilla facial surgery, Robotic surgery

INTRODUCTION

In the discussion of maxillofacial surgery, we have different classification of problems. Maxillofacial surgery patients have a variety of problems, including craniofacial deformities, cleft palate, lip, head and neck tumors, and most importantly, facial trauma. The treatment of these problems in itself will not only impose a high cost on patients and a large extent of the surgical area, it will also result in extensive and extensive reconstruction of the maxillofacial area. Maxillofacial surgeries with large incisions are performed through the trans mandibular and trans pharyngeal approach. Due to the limited surgical space and its complex anatomy, these techniques typically cause morbidity, difficulty speaking and digestion disorders [1]. The introduction of robotic systems and the use of computer programs was a tremendous advancement in maxillofacial surgery. However, this device had also been used in orthopedic, urology, and gynecology surgeries prior to maxillofacial surgery [2]. The Surgerian Robot was a computer-driven device with 3 arms and 6 types of freedom of movement. Each arm consists of 2 parts and 3 joints that work by guiding through the microphone or with the help of a surgeon or an automatic. The first robot device invented in honor of the great painter of the 15th century, Leonardo da Vinci, who painted an iron man in one of his paintings, was called the da vinci system [3].

Transoral robotic surgery (TORS) was proposed and first applied clinically in maxillofacial surgery by Melder and McLeod [4] to excise a vallecular cyst. The first robotic surgical system was introduced in the mid-1980s to orient a needle for brain biopsy [5].

The first application of a robotic surgical system in maxillofacial tumors was reported by Haus et al for resection of the submandibular gland in animal models [6].

After developing robotic surgery in maxillofacial surgery, several applications in this field look like, lymph node dissection, head and neck cancer, pharynx and larynx tumors, salivary gland tumors, obstructive sleep apnea, orthognathic surgery, cleft palate and lip and zygomatic complex fracture, were done. Several studies subsequently focused on the application of TORS in various types of neoplasms, including squamous cell carcinoma, Mucoepidermoid carcinoma, malignant melanoma, synoviosarcoma, adenoid cystic carcinoma, pleomorphic adenoma, lipoma and neurilemmoma [7-10].

Advantages: Advantage of surgeon robot in maxillofacial surgery over radical surgery in laryngeal and oropharyngeal cancers, better recovery power.

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The risk of tumor margin being negative, recovery without recurrence and less risk of bleeding, less chance of gastric tube and tracheostomy, etc. However, the same holds true for the rest of the Surgery's robot indications [11].

Recovery of patients with non-smoking HPV+ oropharyngeal cancers after TORS treatment was better than surgery and radiotherapy [12,13].

Disadvantages: Like any other method, it had its disadvantages as well as its disadvantages, including lack of tactile and proprioceptive sensation, more difficult bleeding control due to limited access, high elasticity suture.

More likely to be tongue edema than conventional surgery is due to too much pressure and too long during surgery, and perhaps the most important problem was the high cost of the device and its equipment and the large space for maintenance and the need for skilled workforce [14,15].

Be it along with the advantages and disadvantages of the said robot, there were a number of contraindications to the robot, including: invasive of tumor to mandible, tumor of cervical that don't need to resection , resection of base of tongue over than 50%, resection of posterior wall of pharynx over than 50%, radiologic verifying in carotid artery involvement , adhesion of prevertebral fascia to tumor , high cost , and it's worth noting that in the treatment of lacerations, the robot had been able to suture the skin and mucosal surfaces. And deep organ ruptures near the orbit were considered a risk with this technique [16,17].

Theodossy [18], compared the two orthognathic surgical models with conventional and robotic techniques, and observed that the robot-assisted surgical model was more accurate in vertical and anterior-posterior planes than in conventional methods.

Terries [19], in his review article, investigated the endorobotic application of the sub mandibular and lymph node resection, resulting in shorter surgical time and better surgical quality with the robot.

Walvekar [20], reports on the elimination of two-way oral ranulas with robotic surgery and da Vinci system, helping to preserve lingual nerve and warton's duct with functional results.

Rawagichi [21], performed a stereo radiotherapy imaging with a robot full of gingival maxillary and lung cancer patients, who observed less toxicity and no recurrence in 2years follow up.

In Iran, in May 2019, in collaboration with Amirkabir University of Technology and Tehran University of Medical Sciences and the Vice President of Science, the design and construction of an oral maxillofacial surgery robot was undertaken.

Perform telemedicine surgery using a robot that can perform surgeries at a distance of kilometers away from the patient's location. This allows the robot to perform surgery [22].

Han [23], used from robot in his research. Surgical navigation was performed using an optical tracking system (OTS) (Polaris Spectra, Northern Digital Inc., Waterloo, ON, Canada). The OTS simultaneously tracked the tracking tools which are attached on the end-effector of the robot arm and the patient's head (the reference tracking tool). Because the end-effector, occlusal splint, and maxillary segment form one rigid body during surgery, the maxillary segment also can be tracked based on the spatial relationship between the end-effector and the maxillary segment. The planned and current maxillary positions can be visualized in axial, sagittal, and coronal planes, and the deviations at five dental landmarks, including the midpoint of the incisal edge of both central incisors, both upper canines, and the mesio-buccal cusp of both upper first molars, can also be provided in real time.

Wu [24], presented application of robots in dental implantology. In the United States, the first robotic dental surgery system was cleared by the Food and Drug Administration for dental implant procedures in 2017. At the end of 2017, the world's first autonomous dental implant placement system was developed by Zhao and colleagues in China. This so-called intelligent robot had a high degree of autonomy, can automatically adjust during intraoperative procedures, and can execute surgical tasks directly on patients without any apparent control by a surgeon.

One of the most important issues in tele operative surgery was touch feedback. And it reduces the ability to sense the properties of the tissue under operation. Another disadvantage was the increased distance between the physician and the patient and the possibility of a 25-second delay for monitors and patients' unwillingness and costly devices.

Remote Surgery Uses: Treatment of soldiers in battlefields, treatment and in-vessel surgery for in-ship personnel, surgery in remote and disadvantaged areas, and surgical operations in space, and collaborating and consulting with surgeons around the world during surgery.

MATERIALS AND METHODS

Articles in PubMed, google scholar Medline databases on jaw surgery in maxillofacial surgery were reviewed in 1999-2021.

A number of articles were abstract and most of them were fully available. Non-English language articles were removed.

RESULTS

Using TORS in maxillofacial surgery can reduce blood loss, decrease surgical time, faster recovery of complex fractures, more effective treatment of cleft palate, decrease in hospital stay, decrease the risk of dysphagia during tumor surgery. Larynx and faster recovery of non-smoker HPV + patients with squamous cell carcinoma of the mouth.

But it also had to do with the high cost of the device, the careful training of staff, difficulty accessing some areas, the surgeon's sense of touch.

CONCLUSION

What can be concluded from this review article was that surgeon robotics as an almost emerging science, especially in the field of maxillofacial surgery, can pave the way for new treatments for the most extensive surgeries in this area.

The many benefits of TORS have increased the use of this computer machine. To the extent that disadvantages such as high cost can be reduced to acceptable levels by placing this device in government service centers.

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