

Minimally invasive transoral robotic surgery for hiloparenchymal submandibular stone: technical note on Flex Robotic System

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Abstract

We described a minimally invasive technique for transoral removal of deep hiloparenchymal submandibular stones by Flex Robotic System; a step-by-step description of the transoral robotic approach to submandibular gland through a discrete incision of the oral floor is narrated. This approach guaranteed the preservation of the gland, minimizing complications.

Introduction

Sialolithiasis is the most common cause of salivary gland disease, involving the submandibular gland in 80-90% of cases.¹ Most submandibular stones have a discrete size of 5-10 mm and are located in the distal tract of Wharton duct, the hilum, and the hilo-parenchymal area.^{2,3} The differing size of the stones, as well as their location is surgically significant. Proximal duct and hiloparenchymal submandibular stones are traditionally treated with transcervical sialadenectomy. Main risks are injury to the facial, lingual or hypoglossal nerves, facial artery bleeding, infection and unaesthetic scars. On the other hand, salivary glands can restore their function after stone removal. Therefore, conservative techniques, such as sialendoscopy and sialendoscopy-assisted transoral procedures, have been developed in the last years.⁴⁻⁶ However, only mobile and small submandibular duct stones ([?]4 mm) can be treated by means of interventional sialendoscopy alone.⁶ Indeed, a combined sialendoscopy-assisted transoral approach is necessary in most cases.⁶ Then, sialendoscopy-assisted transoral surgery for large sizes (>7 mm) and deep hilo-parenchymal stones emerged as a valid alternative to transcervical submandibular sialadenectomy.⁴⁻⁶

The spread of robotic technology in the head and neck field especially for oropharyngeal disorders has favored its application also for the management of anterior oral floor diseases.² In the last years, transoral robot-assisted removal of submandibular gland stones has been described using the Da Vinci Si HD (Intuitive Surgical, Sunnyvale, CA).² Flex Robotic system (Medrobotics Inc., Raynham, MA, USA) represents another minimally invasive and validated approach for head and neck cancer surgery.⁷ Here, we describe a minimally invasive technique for transoral removal of deep parenchymal submandibular stones by Flex Robotic System. We provide a step-by-step description of the transoral robotic approach to the Wharton's duct and the parenchyma of the submandibular gland through the oral floor.

Case history, examination and investigations

In January 2020, a 56-year old male presented at our Department because of a right submandibular stone, determining recurrent submandibular swelling lasting five months. No comorbidity was reported. Clinical examination showed right enlarged submandibular gland. Ultrasonography demonstrated a right salivary

stone that, at computed tomography, measured 25 x 15 mm and was located near glandular hilum (Figure 1a). The subject has given his informed consent to publish his case. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) and the Institutional Review Board.

Treatment

Inclusion criterium for robotic transoral removal of submandibular stones is the presence of palpable stones >7 mm. Exclusion criteria include trismus (inability to open the mouth) and stones not palpable in the oral floor notwithstanding the external cervical finger pressure independently of size.

The procedure was performed under general anesthesia with a nasotracheal tube. The Flex Robotic system was docked behind the head of the patient. Two robotic instruments, a Maryland dissector and a monopolar cautery, were placed into arms of the robot. The Flex retractor was positioned to retract the tongue to the contralateral side and to flatten the oral floor. The robotic surgeon moved the Flex scope looking at three-dimensional High Definition (3D-HD) monitor through a controller on top of the Flex console. The assistant provided suction and external pressure over the submandibular gland. The stone was localized through transoral palpation and its projection marked on the mucosal surface of the oral floor (Figure 1b). A mucosal incision was performed along the marked line using the monopolar cautery of the robot. The proximal third of the Wharton's duct was exposed till the hiloparenchymal area through a blunt dissection with Maryland dissector and the help of the assistant surgeon who moved it upward through external finger pressure. The lingual nerve was identified and mobilized from the duct and retracted medially. An incision over the stone was done with the monopolar cautery (Figure 1c); the stone was then dissected en bloc with the help of the spatula and the Maryland dissector and finally removed. The Flex Robotic system was moved away in order to complete the surgical procedure with a traditional transoral approach. Surgical cavity was irrigated with saline solution to clear any debris. A hemostatic and antimicrobial surgical net (Tabotamp, Johnson & Johnson Medical Limited, Gargrave, Skipton, UK) was positioned over the duct incision and the oral mucosa was closed with absorbable 3-0 vycril stitches. The stone was then measured in size and compared to the shape in the CT images. Antibiotic therapy (amoxicillin and clavulanic acid) was delivered as prophylaxis for five days after the operation.

Outcome and follow-up

The total procedure time was about 30 minutes, including 10 minutes for the robotic setting, thus minimizing tissue damage in the oral floor and subjective complaints. The patient was discharged the first day after surgery. The patient was clinically re-examined after one week, one month and three months after surgery to evaluate the course of wound healing and the recovery of clear secretory flow from the papilla after gland massage. An ultrasonographic examination was performed three months after the procedure to check the echogenicity of the glandular parenchyma and ascertain any ductal system dilation or residual stones. No post-operative complications, such as tingling of the tongue, persistent lingual nerve injury, ranula, or recurrent sialadenitis due to hilar stenosis, were observed.

Discussion

Transoral approach can be considered a simple and successful procedure to treat large (>7 mm) and deeply located stones (proximal duct and hilo-parenchymal area) of submandibular gland.^{5,6}

Recently, transoral robotic surgery (TORS) has become a valuable approach in head and neck cancer surgery, and it has been progressively adopted also for anterior oral floor diseases.⁷ Initial experiences of transoral robot-assisted treatment of submandibular sialoliths have been performed with the Da Vinci robotic system.⁸ Its limitations are the rigid and relatively bulky robotic arms, a limited number of cutting devices available, and high costs.⁸ In the last years, the Flex Robotic System has been specifically developed for head and neck surgery.⁷ It is as safe and effective in transoral robotic surgery for lesions in the oropharynx, hypopharynx, or supraglottic larynx.⁷ Despite the increasing literature showing successful results with the Flex Robotic system for head and neck tumours, it has never been applied to the anterior oral floor.

The aim of this paper was to describe the transoral robotic approach with the Flex Robotic system for the removal of a giant (25x15 mm) and deep hyloparenchymal submandibular stone. No problems were found during docking, that appears comfortable and easy to set with Flex retractor. This system, being easier to handle than the Da Vinci system, allowed a fast and simple setup. The stone was successfully removed en bloc, without per-operative complications. The total procedure time was about 30 minutes, thus minimizing tissue damage in the oral floor and subjective complaints. A minimally invasive approach with a smaller incision of the oral mucosa was done and this was favored by the size of the stone that made it clearly palpable; usually, in loupe lens guided transoral surgery the extent of the oral mucosa incision is wider and this approach permits an adequate and safe check of anatomical landmarks bringing to hyloparenchymal area. Maryland dissector guaranteed blunt dissection of proximal third of the Wharton's duct till the parenchyma to follow the stone in a clean surgical field, favoring a better view of the deep surgical plane. No post-operative complications were observed.

According to our experience the main errors to avoid are:

- to perform the procedure without a correct position of the Flex retractor and an appropriate exposure of the oral floor, this may lead to an inadequate surgical field;
- to perform the procedure without external pressure over submandibular gland, this may make the stone identification difficult and increase the risk of injuries to Wharton's duct and lingual nerve;
- to make an excessive use of the monopolar cautery, this may favor the heat transmission to the lingual nerve with consequent injury;
- to perform a wide incision of the duct, not only over the stone, this may increase the risk of post-operative ductal stenosis.

The 3D view of the surgical field, guaranteed by the Flex Robotic system, improves the visualization allowing the surgeons to have a clearer anatomical delineation and enhances depth perception of oral floor. Furthermore, the shared 3D-HD monitor allows the second surgeon to have the same view of the first surgeon that is promptly helped through suction, tissue traction, and push-up of the gland from the neck.

Unlike Da Vinci instruments, which are rigid, bulky, and controlled by a remote robotic system, the Flex Robotic instruments, easier to handle, are controlled behind the patient by the surgeon's hands, ensuring haptic feedback and tactile sensation, allowing to control the force applied to the tissue.⁶ Different instruments are available, whose flexibility combined with flexible robotic scope ensure an optimal visualization and maneuverability in a small and deep surgical field.

In conclusion, surgical transoral removal of large (>7 mm) and deep submandibular stones with the Flex Robotic system appears to be a minimally invasive, safe and effective conservative procedure with maximal functional and aesthetic outcome. Furthermore, the preservation of the Wharton duct allows sialendoscopic access in case of residual microliths, or to perform a new conservative transoral approach in case of stone recurrence.

Authors contributions:

Pasquale Capaccio: Conception and design of the study, writing and final revision of the manuscript

Giuseppe Riva: Data acquisition and interpretation, writing of the manuscript

Raffaella Cammarota: Data acquisition and interpretation

Michele Gaffuri: Data acquisition and interpretation

Giancarlo Pecorari: Conception and design of the study, final revision of the manuscript.

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Figure legends

Figure 1. (A) Axial Computed Tomography that shows the presence of right salivary stone (black asterisk) in the posterior part of the oral floor (25 x 15mm). (B) The location of the salivary stone was marked on the mucosal surface through palpation. (C) Transoral robotic surgery with Flex Robotic System: a parenchymal incision was performed over the stone (white asterisk) that was carefully dissected and removed.

