Oral and Maxillofacial Surgery
https://doi.org/10.1007/s10006-018-0674-1

CASE REPORT

# Sialolith removal in the submandibular region using surgical diode laser: report of two cases and literature review

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Received: 1 June 2017 / Accepted: 9 January 2018
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## Abstract

**Purpose** Sialolithiasis is defined as the presence of one or more calcified structures within the duct of a major or minor salivary gland. It occurs as a result of deposition of calcium salts around an accumulation of organic debris in the duct lumen. The main signs and symptoms are edema and bacterial infection with abscess formation.

**Methods** This study aimed to report two cases of submandibular sialolithiasis treated surgically with diode laser and conduct a review of the literature by means of a systematic search. In the two cases, the calculi were located in the distal part of the submandibular duct and could be palpated intraorally. Surgery was performed in an outpatient setting under local anesthesia. A linear incision was made in the floor of the mouth, in the region of the opening of Wharton's duct, to expose and remove the calculi. Laser cutting was performed using a diode laser module coupled to a 400-μm optical fiber emitting at a wavelength of 980 nm (infrared), 2.5 W output power, and in continuous pulse mode.

**Results** The use of diode laser is a safe and minimally invasive option for this type of procedure.

**Conclusion** Offering advantages such as enhanced coagulation properties and high-quality incision, absence of bleeding, low risk of nerve damage, and few comorbidities.

**Keywords** Sialolithiasis · Salivary glands · Diode lasers

## Introduction

Sialolithiasis is defined as the presence of one or more oval or round calcified structures (referred to as salivary stones or calculi) within the duct of a major or minor salivary gland. Obstruction of the salivary duct can cause transient swelling of the concerned gland at mealtimes and bacterial infection [1]. Most salivary gland inflammatory diseases, as well as most sialolithiasis cases, occur in the submandibular gland [2].

The development of submandibular calculi is believed to result from accumulation of organic material within the duct, followed by deposition of inorganic substances, both derived from salivary fluid [3], associated with the length and tortuous nature of the path of the submandibular duct around the mylohyoid muscle [4]. Approximately 40% of all submandibular calculi are located in the distal part of the duct and can be removed by surgical procedures performed under local anesthesia. For calculi located in the proximal part of the duct or within the submandibular gland, sialoadenectomy has been the treatment of choice [5].

Recent surgical techniques using lasers have been employed in the treatment of sialolithiasis, including the use of pulsed-dye laser beam for the fragmentation of salivary calculi [6], $CO_2$ laser treatment [7], and the use of Erbium:YAG laser for endoscopic lithotripsy of salivary calculi [8]. Another type of laser used in the oral cavity is the diode laser, which has several advantages including enhanced coagulation properties and the quality of the incision effected by the equipment, thus benefiting postoperative rehabilitation [9].

The aim of this study was to report two cases of submandibular sialolithiasis treated surgically with diode laser through an intraoral approach and conduct a review of the

**Electronic supplementary material** The online version of this article (https://doi.org/10.1007/s10006-018-0674-1) contains supplementary material, which is available to authorized users.

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Published online: 22 January 2018

literature by a systematic search for relevant articles on the use of lasers for the surgical removal of sialoliths from the salivary glands.

## Case report

Between July 2013 and June 2014, two patients were referred to the Oral and Maxillofacial Surgery and Trauma Service at Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Brazil, due to the presence of sialolithiasis in the mandibular region. A preliminary diagnosis of submandibular sialolithiasis was made after clinical examination associated with imaging tests, including mandibular occlusal radiograph and cone-beam computed tomography (CBCT). The present study was performed under the principles of the Declaration of Helsinki and ethical approval by Pontificial Catholic University of Rio Grande do Sul (CEP 12/02890). Written informed consent was obtained from the patients for publication of this case series.

### Surgical technique

In both patients, local anesthetic infiltration was performed in the sublingual region near the salivary calculus with injection of 4% articaine, associated with 1:100,000 epinephrine to effect local vasoconstriction. Only one 1.8-mL cartridge of anesthetic solution was required for nerve block.

Surgical treatment was performed the same surgery and with a diode laser module (DC-International LLC, Model DenLase-980/7, China) coupled to a 400-μm optical fiber emitting at a wavelength of 980 nm (infrared), 2.5 W output power, and in continuous pulse mode. No cooling technique was used on irradiated tissues.

Intraoral access was obtained by making a linear incision along the path of Wharton's duct in the floor of the mouth posterior to the sublingual caruncle. Tissues were dissected with blunt forceps and cuts were made with use of the diode laser. In the two cases, the calculi were located in the distal part of the submandibular duct and could be palpated intraorally. No suturing was performed and wounds healed by secondary intention. No intraoperative complications were reported.

The following drugs were prescribed postoperatively: oral amoxicillin (500 mg) every 8 h for 7 days and oral acetaminophen (750 mg) every 6 h for 3 days.

Both patients were evaluated on days 7, 14, and 30 after surgery and were found to be asymptomatic. The patients remain under regular follow-up every 6 months at PUCRS Oral and Maxillofacial Surgery and Trauma Service.

### Case 1

A 33-year-old man presented with fever, edema and pain in the right sublingual region for 6 days. He reported having used analgesics and anti-inflammatory drugs for a short period of time to alleviate symptoms. He had no significant medical or family history.

Intraoral palpation revealed a firm mobile mass in the right sublingual region (Fig. 1a). A mandibular occlusal radiograph showed a round radiopaque area located in the sublingual region. The CBCT scan showed two calcifications within the duct of the submandibular gland, compatible with the diagnosis of sialolithiasis (Fig. 1b, c, d, e, f).

An additional blood test and abdominal ultrasound were ordered to investigate other possible sites of calcification, which was not observed.

The patient was treated surgically with diode laser. The two sialoliths that were blocking the submandibular duct were removed (Fig. 2). During removal, there was abundant purulent material associated with retained saliva within the duct (Fig. 3). Wharton's duct was dilated due to the size of the sialoliths: the most distal sialolith was approximately 30 mm in diameter and the most proximal sialolith was approximately 15 mm in diameter (Fig. 4).

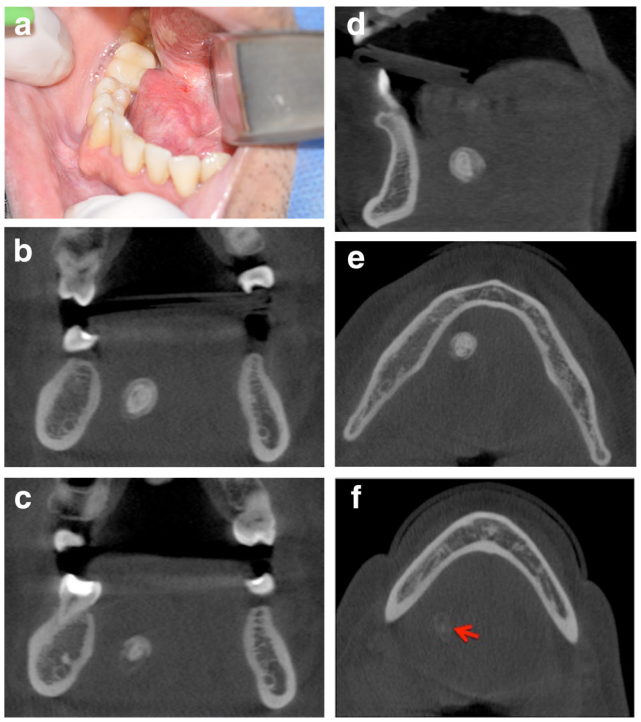


**Fig. 1** **a** Sialolithiasis diagnosis. A firm mobile mass in the sublingual region. **b** Salivary calculus within Wharton's duct distal to the submandibular gland (red arrow). Cone-beam computed tomography (CBCT) coronal view. **c** Salivary calculus within Wharton's duct distal to the submandibular gland (red arrow). Cone-beam computed tomography (CBCT) coronal view. **d** CBCT sagittal view. **e** CBCT axial view. **f** Less calcified salivary calculus within Wharton's duct proximal to the submandibular gland (red arrow). CBCT axial view

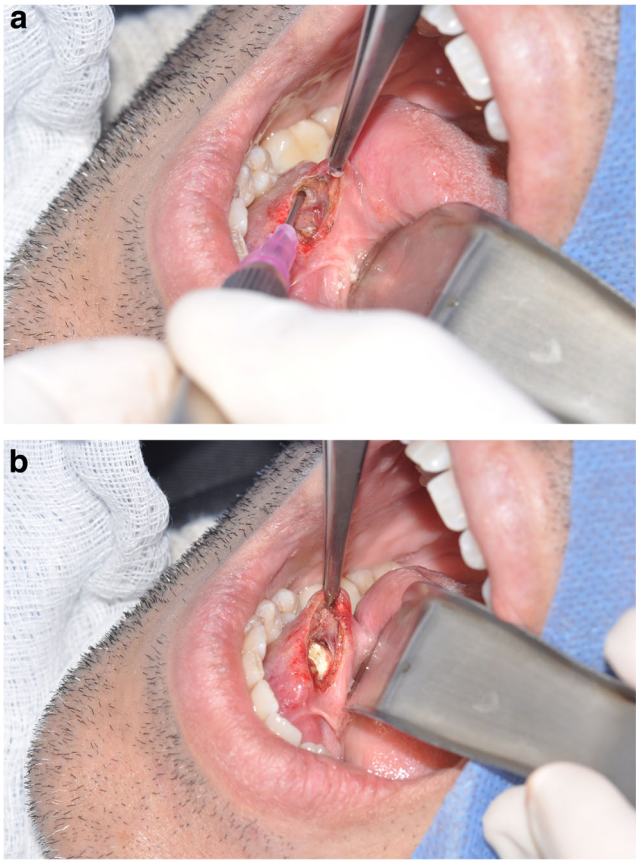


**Fig. 2** **a** Outpatient surgical procedure. Surgical approach with a diode laser. Incision and cauterization of the tissue. **b** Salivary duct lumen with the sialolith located most distal to the submandibular gland

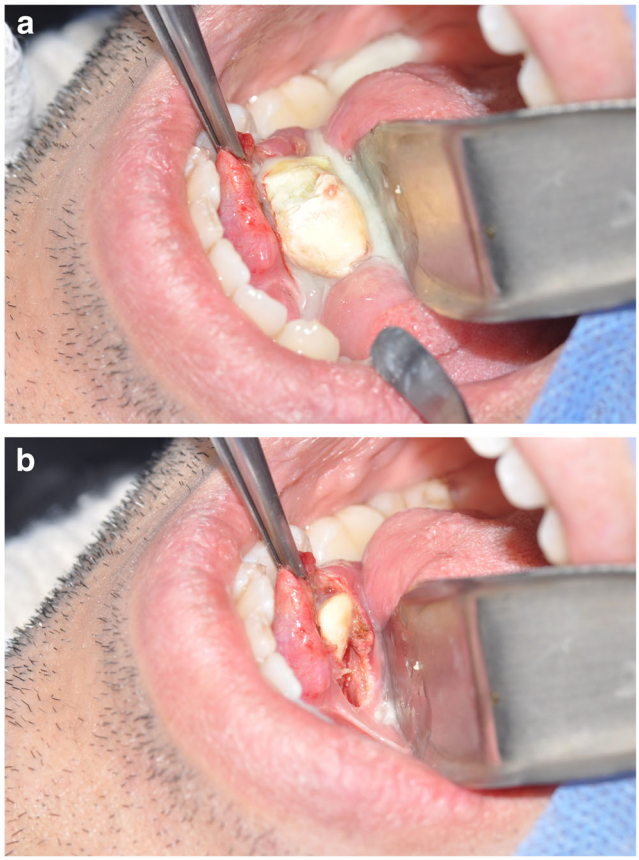


**Fig. 3** **a** Removal of the most distal salivary calculus with drainage of purulent material and salivary fluid. **b** Removal of the salivary calculus located most proximal to the submandibular gland

After 7 days, the patient was reexamined and reported no discomfort on the region and had no postoperative complications. The surgical wound was completely healed within 14 days. There was no recurrence of sialolithiasis at 36-month follow-up.

## Case 2

A 93-year-old woman, taking simvastatin, enalapril, and aspirin, presented with clinical signs of infection in the right sublingual region and reported pain when eating for at least 5 days. During history taking, the patient reported that she had undergone an intervention for treatment of sialolithiasis in the same region 15 years earlier. Preoperative blood tests were ordered and showed no abnormalities.

A mandibular occlusal radiograph showed a radiopaque area located in the right side of the floor of the mouth, compatible with the clinical diagnosis of recurrent submandibular sialolithiasis. The patient was treated surgically with diode laser. Three calculi of approximately 4, 8, and 3 mm diameter each were removed, as shown in the video of the surgical technique (Video 1).

After 7 days, the patient reported no postoperative complications. The surgical wound was completely healed within 14 days, and there was no recurrence of sialolithiasis at 24-month follow-up.

## Review of the literature

A systematic literature search was conducted independently by two authors (OLHJ and NS) using MEDLINE (accessed via PubMed) and EMBASE electronic databases and Google Scholar. The authors also hand searched the reference list of all selected articles to identify additional potentially relevant studies. No limits were applied for language or year of publication. Clinical trials, case series, and case reports describing the surgical technique and type of laser used to surgically remove sialoliths from the ducts of salivary glands were eligible for inclusion in this review. The last electronic search was conducted on August 26, 2016.

The following search strategy using Medical Subject Headings (MeSH) was applied to MEDLINE/PubMed: ("Salivary Gland Calculi" or "Calculi, Salivary Gland" or "Calculus, Salivary Gland" or "Gland Calculi, Salivary" or

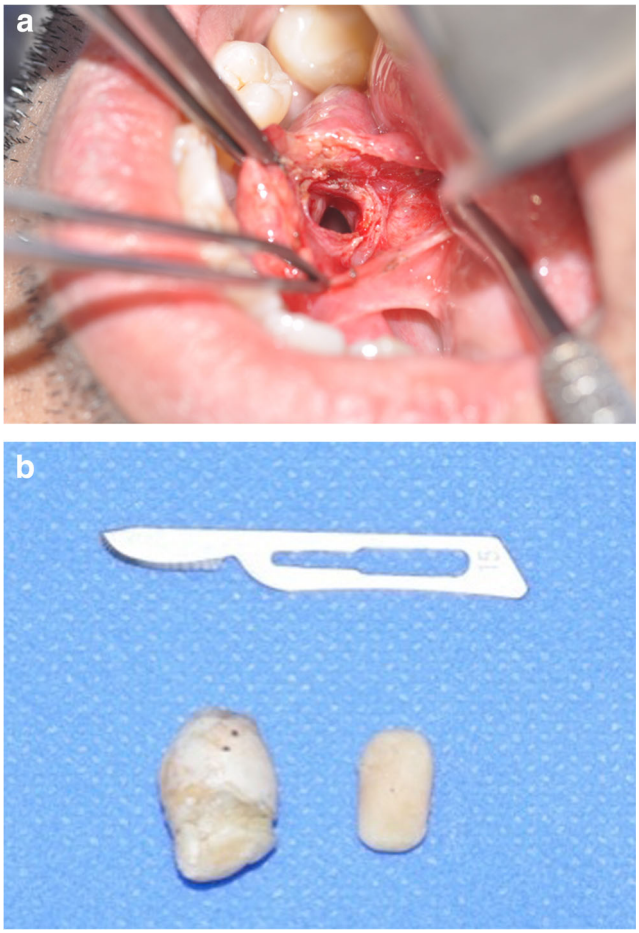


**Fig. 4** **a** Wharton's duct lumen without postoperative suture to prevent ranula formation and drainage of salivary fluid. **b** Removed salivary calculi

"Gland Calculus, Salivary" or "Salivary Gland Calculus" or "Sialoliths" or "Sialolith" or "Salivary Gland Stones" or "Gland Stone, Salivary" or "Gland Stones, Salivary" or "Salivary Gland Stone" or "Stone, Salivary Gland" or "Stones, Salivary Gland" or "Salivary Duct Calculi" or "Sialolithiasis" or "Calculi, Salivary Duct" or "Calculus, Salivary Duct" or "Duct Calculi, Salivary" or "Duct Calculus, Salivary" or "Salivary Duct Calculus" or "Parotid Duct Calculi" or "Submandibular Duct Calculi" or "Salivary Duct Stones" or "Duct Stone, Salivary" or "Duct Stones, Salivary" or "Stone, Salivary Duct" or "Stones, Salivary Duct" or "Sialolithiasis, Ductal" or "Sialolithiases, Ductal") and ("Laser Therapy" or "Laser Therapies" or "Therapies, Laser" or "Therapy, Laser" or "Vaporization, Laser" or "Laser Vaporization" or "Laser Ablation" or "Ablation, Laser" or "Laser Tissue Ablation" or "Tissue Ablation, Laser" or "Pulsed Laser Tissue Ablation" or "Laser Photoablation of Tissue" or "Nonablative Laser Treatment" or "Laser Treatment, Nonablative" or "Laser Treatments, Nonablative" or "Nonablative Laser Treatments" or "Laser Scalpel" or "Laser Scalpels" or "Scalpel, Laser" or "Scalpels, Laser" or "Laser Knives" or "Knife, Laser" or "Knives, Laser" or "Laser Knife" or "Laser Knife" or "Knife, Laser" or "Knifes, Laser" or "Laser Knifes" or "Laser Surgery" or "Laser Surgeries" or "Surgeries, Laser" or "Surgery, Laser"). The search returned 39 articles, of which five studies [7, 9–12] met the inclusion criteria.

The EMBASE database was searched using Emtree terms as follows: 'sialolithiasis'/syn and 'laser surgery'/syn. The search returned 12 articles. Of these, five were selected, but only one study [13] was included because the other four had already been retrieved from the MEDLINE/PubMed database.

Google Scholar was searched using the main MeSH terms as follows: ("Salivary Gland Calculi" or "Salivary Duct Calculi") and "Laser Therapy." The search returned 68 articles, but only one study [14], which had not been previously retrieved from MEDLINE/PubMed and EMBASE databases, was included.

No additional studies were obtained by checking the reference lists.

Therefore, a total of seven studies without language restriction were ultimately included in this review of the literature (Table 1).

## Discussion

In this study, we conducted a review of the literature by means of a systematic search using the main databases rather than a systematic review for which we would need to formulate a research question based on the PICOS criteria, analyze the studies with increased methodological rigor, and assess the quality of the included studies [14]. Our goal was to standardize the search criteria to allow the search strategies to be reproduced by the readers who are interested in the use of lasers for the surgical removal of sialoliths from the salivary glands and to provide the current authors with a broader scientific basis to prepare the manuscript. We believe that this goal was achieved as the two independent reviewers obtained the same search results (seven included articles). As no language restriction was applied, an article not written in English was identified and included [12]. Also, articles retrieved from different databases were included (MEDLINE/PubMed = 5 studies [1, 10–13], EMBASE = 1 study [15] and Google Scholar = 1 study [16]).

In addition to providing a more comprehensive literature review, the systematic search allowed us to extend the comparison of the retrieved studies to the two cases reported here. This approach also made it clear the lack of prospective clinical trials and the small number of case series (five studies [7, 10, 12, 13, 15]) on the topic. From this point of view, this study is unique in that it is the first to provide a reproducible literature review and an organized summary of clinical data on the use of lasers in the surgical treatment of sialolithiasis.

**Table 1** Report on the use of two types of laser for surgical treatment of mandibular sialolithiasis

| Author, year | Study design | *N* | Age, year (range) | Anatomic site | Diagnostic method | Sialolith size | Laser parameters | Surgical protocol | Postoperative complications |
|---|---|---|---|---|---|---|---|---|---|
| Barak et al., 1991 [10] | Case series Retrospective | 13 | 44 (21–72) 62 (46–74) | WD (10) SD (3) | Not reported | Not reported | CO2 5 W/10 W continuous | Local anesthesia, no suture | None |
| Barak et al., 1993 [11] | Case series Retrospective | 6 | 30 (19–54) | WD (5) HSG (1) | Clinical and radiographic | 2.5 mm (2-3 mm) | CO2 10 W continuous | Local anesthesia, no suture, ±14.3 min of operating time | None |
| Azaz et al., 1996 [7] | Case series Retrospective | 49 | 45 (15–85) | WD (47) SD (2) | Clinical and radiographic | Not reported | CO2 8 W continuous | Local anesthesia | Suppuration (11) Fever (2) Recurrence (1) |
| Buhilla et al., 2000 [12] | Case report | 1 | 13 | WD | Clinical, radiographic, US, and sialographic | 2.5 × 1.5 mm | CO2 10 W continuous, 10,600 nm wavelength | General anesthesia, no suture | None |
| Angiero et al., 2008 [15] | Case series Retrospective | 25 | (16–72) | WD | Clinical, radiographic, CT (few cases) | 15 mm (3–45 mm) | Diode 2.5 W continuous, 810/830 nm wavelength, 300/320 μm optical fiber | Topical anesthesia and desensitization with the l aser beam at some distance, tissue cooling with saline, no suture | Duct fibrosis (1) Partial removal (1) |
| Yang and Chen, 2011 [13] | Case series Retrospective | 19 | 30 (8–54) | WD | Clinical, radiographic [1], CT [6], and US [1] | 3.7 mm (1–20 mm) | CO2 4 W/6 W continuous | Topical and general anesthesia (1 case), no suture or absorbable suture | Ranula (1) lesion in the sublingual region |
| Kilinç and Çetiner, 2014 [16] | Case report | 1 | 57 | WD | Clinical and radiographic | 25 mm | Diode 4 W continuous, 810 nm wavelength, 1000 Hz frequency | Local anesthesia, absorbable suture, and duct marsupialization | None |
| Haas Jr. et al., 2015 | Current study | 2 | 33/93 | WD | Clinical, radiographic, and CBCT | 3–30 mm | Diode 2.5 W continuous, 980 nm wavelength, 400 μm optical fiber | Local anesthesia, no tissue cooling, no suture | None |

*WD* Wharton's duct, *SD* Stensen's duct, *HSG* Hilum of the submandibular gland, *US* ultrasound. *CT* computed tomography. *CBCT* cone-beam computed tomography

Clinically, a total of 114 patients operated on with laser for surgical removal of sialoliths from the salivary glands have been reported in the literature. Combining our two cases with those in the literature, a total of 116 cases have been described. Wharton's duct was the anatomic site most commonly affected by salivary calculi—109 cases (95%), including the two cases reported here. Patient age at diagnosis varied widely, from 8 years [13] to 85 years [7]. However, the oldest patient was the one described as case 2 in the present report, who was 93 years old at diagnosis. The patient was on oral anticoagulants, which demonstrated the safety of making an incision with a diode laser in a highly vascularized anatomic site with important varicosities compatible with advanced age.

The diagnosis of sialolithiasis is primarily clinical, associated with panoramic and/or occlusal radiograph [7, 11–13, 15, 16]—only Barak et al. (1991) [12] did not report the use of preoperative diagnostic tests. The signs and symptoms of salivary flow obstruction are well defined, including transient local edema formation and pain before and during meals, with progressive postprandial remission; also, chronic recurrent duct obliteration can cause inflammation and infection [17, 18]. All these features have been confirmed in the literature. However, some studies have demonstrated the need to order more specific imaging tests, such as computed tomography [13, 15], ultrasound [12, 13, 18], and contrast sialography [12, 19], because non-palpable calculi commonly have false-negative results on radiographs [13, 15]. This peculiarity was also observed in case 1 reported here, in which, at first, there was a radiographic diagnosis of a single sialolith, but, as the patient had an important sublingual edema, we felt the need to order a CBCT scan for better surgical planning. Based on these images, the second sialolith, located more proximal to the submandibular gland, was diagnosed at a less advanced stage of calcification, which had made it not visible on the radiograph.

Diagnostic confirmation of this type of disease requires surgical intervention as treatment. Traditionally, surgery is regarded as a challenge that is dependent on the anatomic conditions of the submandibular region and the systemic conditions of the patient. Thus, techniques such as sialoadenectomy [18–20] are considered more invasive and can put many important structures at risk, especially the (motor) marginal mandibular and hypoglossal nerves and the (sensory) lingual nerve. Another complicating factor is the formation of a hypertrophic scar at the site [11]. However, the best treatment option for cases in which the intraductal disease is located in the distal part of the duct is a minimally invasive surgical intervention using a laser, as reported in the present study. This technique is relatively simple, requires only local anesthesia and can be performed in an outpatient setting by an intraoral approach, since there is decreased bleeding due to hemostasis provided by laser treatment, which reduces the intervention time and operative morbidity [21].

The studies included in this review [7, 10–13, 15, 16] report on the use of two types of laser for surgical treatment of mandibular sialolithiasis (Table 1): two studies used the diode laser [14, 16] and five used the $CO_2$ laser [7, 10–13]. The main difference between these two types of laser lies in the fact that $CO_2$ has an absorption peak close to that of water [22], working best on tissues containing large amounts of water, while the diode laser has peak emissions at wavelengths where the light is mainly absorbed by hemoglobin and melanin [16]. Therefore, the diode laser was adopted in the present study because it is indicated for procedures in patients with coagulation disorders, such as the patient described as case 2 here, without the need to discontinue the anticoagulant therapy before surgery [22]. In addition, the diode laser can be used in surgical procedures involving soft tissues of the oral and maxillofacial region, such as in tumor removal, frenectomy, excision of gingival hyperplasia, vestibuloplasty, removal of hemangiomas, adenomas and fibromas, and peri-implant surgery [23]. Its only contraindication is the impossibility of performing histopathologic examination [24], which is not required in cases of sialolithiasis.

None of the 116 reported cases required suturing at the end of surgery, which reduces and/or eliminates the risk of postoperative sublingual ranula formation, thus allowing proper salivary drainage without the need for marsupialization or placement of drains. Furthermore, the effects of laser photobiomodulation on the tissue lead to increased production of collagenase, an enzyme that is potentially effective in the treatment of wounds because of its ability to destroy the collagen cells that form the necrotic tissue of the wound [25]. Thus, by using laser, new cells can be formed and proliferate more easily, leading to enhanced wound-healing quality. In infected tissues and in cases of suppuration, such as in case 1 reported here, the laser incision, which is self-sterilizing, produces a thin surface layer of collagen that serves as an "impermeable dressing", protecting the tissue against irritation caused by oral fluids [26]. This also avoids recurrent and/or persistent infections when there is concomitant patient cooperation for oral hygiene maintenance of the operated site.

All the aforementioned features allow postoperative rehabilitation with minimal swelling, bleeding, infection, and pain, obviating the need for many drugs [27]. The choice of drug treatment in the present study was due to the systemic involvement observed during history taking and on complementary tests. However, traditionally, patients undergoing intraoral laser treatment receive only analgesics and anti-inflammatory drugs after surgery.

In view of the foregoing, we believe that surgical treatment with diode laser is superior to conventional surgical treatment due to the safety and minimal invasiveness of the procedure, resulting in significantly reduced morbidity. Nevertheless, some limitations need to be considered, such as increased operative time and the high cost of equipment.

## Conclusion

The results obtained with the use diode laser and reported in the present study show that this device is extremely useful as a tool to access the salivary gland for the removal of calculi located in the distal part of Wharton's duct. Its use improves postoperative patient comfort while minimizing complications in highly vascularized sites, such as the floor of the mouth. None of the laser-treated patients had intraoperative or postoperative complications.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** The present study was performed under the principles of the Declaration of Helsinki and ethical approval by Pontificial Catholic University of Rio Grande do Sul (CEP 12/02890).

**Informed consent** Informed consent was obtained from the patients for publication of this case series.

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