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The Role of CO_2 Laser in the Intraoral Management of Submandibular Sialoliths: A Clinical Perspective

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ABSTRACT

Background: The term sialolithiasis refers to the condition in which a major or minor salivary gland's duct contains one or more calcified structures. Carbon dioxide (CO_2) lasers have recently emerged as a minimally invasive option for intraoral therapy of submandibular sialoliths. CO_2 lasers minimize postoperative discomfort, scarring, and recovery time by allowing for precision lithotomy with minimum harm to surrounding tissues.

Methods: The purpose of this study was to examine the literature and report on two surgical cases of submandibular sialolithiasis treated with carbon dioxide (CO_2) lasers. The calculi in both cases were palpable intraorally and were situated in the distal portion of the submandibular duct. Under local anesthesia, surgery was done in an outpatient environment. To uncover and remove the calculi, a CO_2 laser was used to make a linear incision in the floor of the mouth at the Wharton's duct opening.

Results: In a matter of minutes, the stone was extracted from both patients, resulting in full recovery and no unusual bleeding, nerve damage, or problems with the sublingual glands.

Conclusion: We describe the benefits and efficacy of the CO_2 laser in two patients who had successful surgical excision of significant salivary stones.

Keywords:

Sialolithiasis; submandibular; salivary gland; Wharton's duct; CO_2 laser; local anaesthesia.

Introduction

The condition known as sialolithiasis is caused by the presence of one or more oval or round calcified formations inside the duct of a major or minor salivary gland. These structures are also known as salivary stones or calculi. The most typical cause of blockage of the salivary glands is sialolithiasis. (1) There may be partial or total obstruction, and symptoms could recur. The ductal system and parenchyma may suffer temporary or permanent damage as a result of the trapped saliva's retrograde pressure on the salivary gland. The majority of sialolithiasis incidents and salivary gland inflammatory conditions occurred in the submandibular gland. (2) The formation of submandibular calculi is thought to be caused by the build-up of organic material inside the duct and the subsequent deposition of inorganic substances, both of which are derived from salivary fluid. (3) This process is linked to the submandibular duct's long and tortuous path around the mylohyoid muscle. (4) In the distal portion of the duct, about 40% of all submandibular calculi are found. These can be surgically removed under local anesthesia.

The recommended course of therapy for calculi situated in the submandibular gland or in the proximal portion of the duct is sialoadenectomy. [5] Sialolithiasis has been treated surgically with recent laser-assisted procedures, such as the fragmentation of salivary calculi using a pulsed-dye laser beam [6], CO2 laser treatment [7], and sialendoscopic lithotripsy of salivary calculi using an Erbium:YAG laser. [8]

Even in the acute stage, prompt sialolithectomy is preferred whenever possible because it allows for the quick release of trapped saliva and the draining of exudate, which in turn allows for the immediate reduction of glandular pressure. This reduces discomfort and speeds up healing. [9,10] Submandibular sialolithiasis is a serious clinical problem that frequently necessitates surgery to remove the stone. Conventional techniques, such as surgical extraction and sialendoscopy, have drawbacks like invasiveness and discomfort following surgery. In order to demonstrate the efficacy, benefits, and possible advantages of CO2 laser technology over traditional procedures, this case study examines its application in the intraoral excision of a submandibular stone. The first account of the benefits of sialolithectomy using a CO2 laser was provided by Azaz et al. in 1989. [9]

We describe the benefits and safety of the CO_2 laser in two patients who had successful surgical excision of relatively large salivary stones in the distal part of Wharton's duct (diameter >1 cm).

There are various benefits associated with a 10.6 µm CO_2 laser. It has a high hemostatic power, is quickly absorbed by water, acts superficially, causes little heat damage to the surrounding tissues, and is simple to use. [6] For these reasons, the excision or vaporization of soft tissues in the mouth is frequently accomplished with a CO_2 laser. (11-15) There are, however, very few reports of its application for the removal of salivary stones. [7,16,17]

Case 1:

The patient, a 33-year-old man, complained of having frequent pain and swelling in the right side of the floor of the mouth for the previous three months, which got worse during meals. He mentioned that he had taken analgesics and anti-inflammatory medications for a little while to help with the pain. He had no significant medical or family history. A clinical examination revealed the right submandibular area to be noticeably swollen. It was tender on palpation. A firm movable mass was detected by intraoral bimanual palpation in the right sublingual area. (figure 1)

Figure 1: Intraoral photograph showing clinical view of a congestive ostium of Wharton's duct swelling on the right side of the floor of the mouth.

The patient was afebrile and there were no indications of a systemic infection. There were no visible salivary duct secretions. An ultrasound was recommended. A distinct, hyperechoic structure near the distal end of the right submandibular duct. The sialolith exhibits posterior acoustic shadowing, which is typical of a calcified mass about 9mm in diameter. (figure 2).

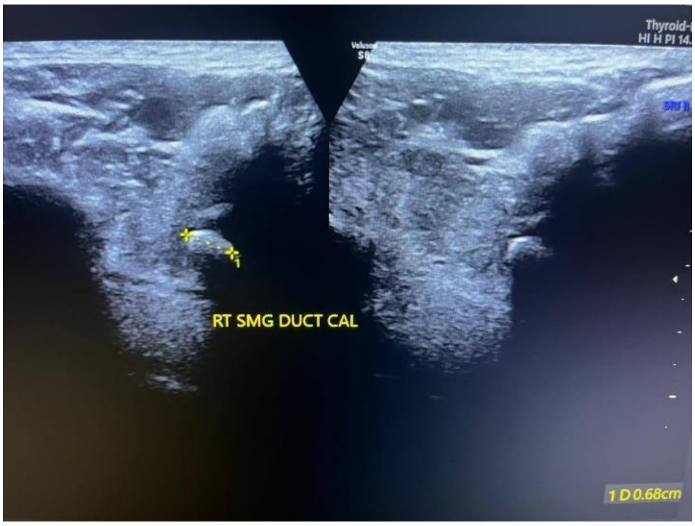

Figure 2. Ultrasonography picture of calculi at distal end of Wharton's duct.

The submandibular gland parenchyma appears normal, with no evidence of acute inflammation or abscess formation. The patient was offered to have the sialolith removed intraorally under local anesthesia with a CO_2 laser after receiving counseling regarding the problem. Under local anesthesia with 2% lidocaine with epinephrine, a 1 cm incision was created in the mucosa of the mouth floor right above the salivary stone using a CO_2 laser (3 W, continuous wave, the spot size 1.00 mm, irradiance 3.18 W/mm2) (figure 3 and 4).

Figure 3. Applying laser beam to take incision near floor of mouth just adjacent to sialolith.

Figure 4. After uncapping of mucosa over the sialolith.

Up till the salivary stone's surface could be easily recognized, the laser was focused on it. Using forceps, the salivary stone was extracted while being careful not to break it. After the stone was removed (figure 5), the submandibular gland was pressed, resulting in the production of saliva. There was no unusual bleeding after the satisfactory completion of the surgical treatment. For thirty days, the patient was monitored to ensure healing and saliva production.

Figure 5. Sialolith after removal

Case 2:

A 35-year-old female patient complained of recurring pain and swelling in the bottom of her mouth on the right side, which worsened with meals. She mentioned that the symptoms have persisted for the past six months. The patient had tried increasing fluid intake and sialogogues without any effect. No chronic ailments or any addictions were recorded. There is no history of systemic disease or prior surgery. An ultrasonography confirmed the presence of a submandibular duct sialolith located at the distal end of the duct, with associated ductal dilation. (figure 7)

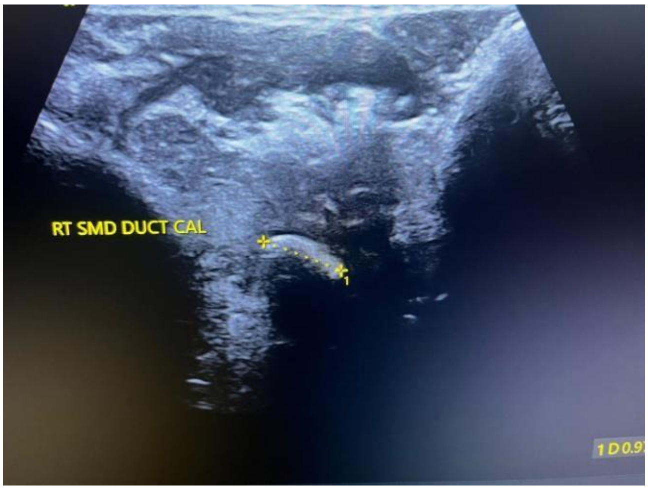

Figure 7. Ultrasonography picture of calculi at distal end of Wharton's duct.

The findings are consistent with sialolithiasis causing obstruction and potential localized symptoms. The patient was informed about the issue and advised to have the stone removed intraorally using a CO2 laser. After obtaining proper consent, A 1 cm incision was made in the mucosa of the mouth floor directly above the salivary stone while under local anesthetic with 2% lidocaine and epinephrine. A CO_2 laser (3 W, continuous wave, the spot size 1.00 mm, irradiance 3.18 W/mm2) was used. The laser was trained on the salivary stone up until it was clearly visible on its surface (figure 6a and 6b)

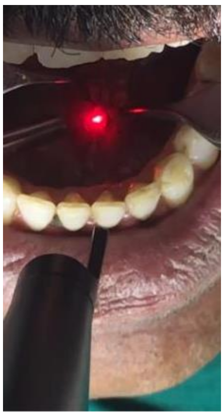

Figure 6a.

Figure 6b.

Figure 6a and 6b. Clinical photograph showing intraoral removal of sialolith

The salivary stone was removed with caution so as not to shatter it, using forceps. Saliva was produced by pressing the submandibular gland after the stone was removed. (figure 7) Patient was on frequent follow-up for three months and was doing well with no recurrence.

Discussion:

Around 60% of the etiology of obstructive salivary gland pathology is due to sialolithiasis, making it the most frequent non-malignant salivary gland pathology. (18,19) The development of calcified calculi as a result of the gradual accumulation of calcium salts surrounding an initial biological nidus is the source of salivary stones. (20) These sialoliths induce the ductal wall to remain inflamed and obstruct the salivary outflow of the glandular parenchyma upstream, which increases the amount of saliva that is produced in reserve. (21) As a result, pressure atrophy, fibrosis, and persistent inflammation may impair the afflicted gland. (22) Visible glandular swelling, sticky or even purulent discharge from the ductal opening, and compressing discomfort are examples of clinical signs. (23)

According to Marchal et al., the existence of a sphincter within the initial 3 cm of the duct may cause different organic and inorganic materials to migrate retrogradely, which may aid in the production of sialoliths. (24) Because submandibular gland saliva contains a larger percentage of mucin than parotid gland saliva, it is known to be more viscous. Compared to parotid saliva, it has a higher pH and twice as much calcium. (25 - 27) A mucoid gel that forms in the ductal system of a submandibular gland is more likely to mineralize as a result of calcium deposits and pH elevation because they reduce the solubility of calcium phosphate in saliva.(25,26,28) According to certain studies, individuals who had sialoliths had higher quantities of calcium in their saliva as well as higher salivary viscosity and protein content.(29-31) Conversely, lower levels of the crystallization inhibitors citrate, magnesium, and phytate, which may increase the risk of developing sialothiasis, were discovered in the afflicted people. (30) In the literature, other factors like smoking, taking diuretics, and having gout were mentioned. (32)

A propensity to produce sialolithiasis, which is primarily made up of uric acid, appears to be linked to gout. (33)

Despite the fact that Sjögren's disease is characterized by lacrimal and salivary gland hypofunction, there was no higher prevalence of salivary stones among these patients, despite the fact that a decrease in salivary flow rate may in fact facilitate the production of calculi. (32) However, since one of the known consequences of diuretics is a decrease in salivary flow, it has been demonstrated that using them can increase the risk of salivary stones. (34,35) According to Huoh et al., patients with salivary stones had a greater rate (statistically not significant) of smoking or a history of smoking than the general population, suggesting that smoking may promote the production of salivary stones. Smoking does, in fact, have the potential to lower saliva's antibacterial action, which could increase the amount of germs present and cause inflammation of the gland or salivary duct. (34)

Figure 8. Specimen of sialolith after removal.

Submandibular sialolithiasis is characterized by painful lumps in the floor of the mouth, scanty salivary discharge from the accompanying orifice duct, and swelling and tenderness over the gland that worsens with meals.

Clinical reports from the literature include 116 people who underwent laser surgery to remove sialoliths from their salivary glands. When our two examples are combined with those found in the literature, 118 cases are described in total. Salivary calculi most frequently affected Wharton's duct, which was involved in 111 cases (95%), including the two examples that are shown here. The age range of the patient at diagnosis was 8 years [13] to 85 years. (7) Sialolithiasis is usually identified clinically employing panoramic and/or occlusal radiographs. (7, 10, 36 - 39) Barak et al. (1991) (36) is the only publication that does not discuss the use of preoperative diagnostic testing. In addition to the well-established signs and symptoms of salivary flow obstruction, such as temporary local edema development and pain before and during meals that gradually go away after eating, chronic recurrent duct obliteration can also result in infection and inflammation. [39,40] The literature has substantiated each of these characteristics.

However, because non-palpable calculi frequently produce false negative results on radiographs [37,38], several investigations have shown the necessity of ordering additional specialized imaging procedures, such as computed tomography [37,38], ultrasonography [36,37,40], and contrast sialography. [36,41]

Surgery is required as a kind of treatment upon diagnostic confirmation of this kind of illness. Traditionally, surgical procedures have been viewed as challenging and contingent upon the patient's systemic illnesses and the anatomical state of the submandibular region. As a result, procedures like sialoadenectomy. [40 – 42] are regarded as more invasive and can endanger a number of crucial anatomical structures, including the lingual nerve and the (motor) marginal mandibular and hypoglossal nerves. The development of a hypertrophic scar at the location is another complicating issue. [10] Nonetheless, as the current study reports, the most effective course of treatment for patients whose intraductal ailments is situated in the distal portion of the duct is a minimally invasive laser surgical procedure. Because laser treatment provides hemostasis, which decreases bleeding and lowers intervention time and operational morbidity, this very straightforward technique can be carried out in an outpatient setting using an intraoral approach. [43]

Two individuals with significant salivary stones (>1 cm diameter) in Wharton's duct were described. The patients underwent surgical excision of the stones by incising the mucosa and submucosal tissue of the mouth floor that covered the stones using a CO_2 laser. In a matter of moments, the stone was removed from both patients without resulting in unusual bleeding, nerve damage, or sublingual gland abnormalities like ranula.

Nevertheless, there aren't many articles outlining the outcomes of sialolithectomy with the CO_2 laser. It is employed in many different medical interventions. [44-47]

There are a number of positive aspects to using this method to treat sialolithiasis. It allows for noncontact, sterile, bloodless surgery in an outpatient clinic while under local anesthesia, even during the acute phase. The secretions and residual saliva immediately discharge when the blocking sialolith is removed. Nearly all patients demonstrated remarkable recovery one week following surgery. The CO_2 laser has a wavelength of 10600 nm. It has a high hemostatic power, is quickly absorbed by water, acts superficially, causes little heat damage to the surrounding tissues, and is simple to use.6. For these reasons, the excision or vaporization of soft tissues in the oral cavity is frequently accomplished with a CO_2 laser. [12-16] There are, however, very few reports of its application for the removal of salivary stones. [7, 17, 37] Due to their near closeness to the submucosa of the floor of the mouth, the sublingual gland and lingual nerve might cause problematic sequelae, including ranula and lingual nerve paralysis, following surgical treatments in this area. [48] We describe the benefits and safety of the CO_2 laser in two patients who had successful surgical excision of relatively large salivary stones (diameter >1 cm).

A definition of the indications for sialadenectomy in connection with sialolithiasis was tried by Yoshimora et al. [49] They came to the conclusion that the gland's chance for healing after sialolithectomy is good or improved. Their investigation is validated by the current results. While CO_2 laser-assisted ablation of submandibular sialoliths shows promise in clinical trials, numerous limitations must be addressed. First, laser technology's availability and pricing can be too expensive in some therapeutic settings, restricting its widespread use. Second, the learning curve for using CO_2 lasers for this treatment necessitates specialized training, which may not be easily available to all practitioners. Finally, the majority of published data are case reports or small cohorts, needing bigger randomized controlled trials to create rigorous clinical guidelines and compare them to older methods. These limitations underscore the importance of more research to fully understand the possibilities and limitations of CO_2 laser applications in submandibular sialolithiasis therapy.

Conclusion:

Submandibular stone removal by intraoral CO2 laser-assisted extraction is a successful, less invasive substitute for conventional surgical techniques. This case study illustrates the procedure's viability and advantages, which include less discomfort following surgery and a quick recovery time. Furthermore, investigating the usability of CO2 lasers for larger or more deeply implanted sialoliths may broaden the scope of applications for this technology. Investigating the cost-effectiveness of CO2 laser treatment in comparison to typical surgical treatments would aid in determining its suitability for widespread clinical use. Finally, improvements in laser technology and training programs should be investigated in order to make the treatment more accessible and reduce potential complications. Future research that addresses these limitations could strengthen CO2 lasers' role in the comprehensive care of submandibular sialolithiasis. To determine long-term consequences and validate these findings over a larger patient population, more research and clinical trials are required.

Compliance with Ethical Standards:

The procedure performed in this case report was in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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This study is not funded by any resources.

Conflict of Interest:

The author (s) declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this paper.

Ethical Approval:

For the purpose of publishing this case report, the patient's written informed consent was obtained.

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