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Case report

Clinical application of computed tomography in the surgical treatment of submandibular mucocele and sialoliths in Dog

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Abstract

A 10-year-old, 8-kg mixed-breed dog presented with a painless, soft and tender submandibular swelling. Radiographs revealed an 8x6 cm ventral cervical mass with radiopaque spots. Fine needle aspiration showed high viscosity and yellow-tinged fluid, indicative of an inflammatory sialocele. After drainage, carprofen (4.4 mg/kg) was administered daily for one week, followed by prednisone (0.5 mg/kg) for the second week. However, the mass recurred after one month, necessitating a computed tomography (CT) scan for surgical management. CT imaging demonstrated an encapsulated fluid-attenuating mass in the submandibular region, containing sludge and calcified materials. Surgical excision and biopsy confirmed a submandibular mucocele with sialoliths. Infrared spectroscopy revealed a high protein concentration in the sialoliths. The CT scan facilitated an accurate diagnosis and the formulation of a proper treatment plan for this canine cervical mass that was consistent with submandibular mucocele and sialolithiasis.

Keywords: CT, Dog, Sialoliths, Submandibular Mucocele

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INTRODUCTION

A sialocele, also known as a salivary mucocele, is a collection of salivary fluids in the subcutaneous or submucosal layers that is encapsulated by fibrous connective tissue. The commonly affected glands are sublingual, parotid, pharyngeal, zygomatic and mandibular glands (Davoud et al., 2012; Lieske and Rissi, 2020; Tan et al., 2022). There are several possible underlying causes of a sialocele, including trauma, a foreign body, sialolithiasis, neoplasia and the leakage of saliva followed by inflammation (Ritter et al., 2006; Benjamino et al., 2012; Cinti et al., 2021; Timur et al., 2022). Sialocele formation secondary to sialolithiasis is rare in dogs, with one study reporting the occurrence in 3.5% of dogs with sialocele. (Cinti et al., 2021). Sialolithiasis is characterized by the production of calcified secretions in salivary glands or their ductal system (Trumpatori et al., 2007; Lee et al., 2014). Mucus plugs, inflammatory debris, bacteria and foreign elements have all been described in previous studies that serve as the organic nidus for the formation of sialoliths (Kwon et al., 2009; Lee et al., 2014). Additionally, sialoliths might be related to prolonged unusual salivary flow and result in salivary retention (Trumpatori et al., 2007). The formation of a sialolithiasis is more commonly reported in older dogs of 10-15 years of age (Han et al., 2016).

The diagnosis of sialolithiases and sialoceles is typically performed using imaging techniques, including plain film cervical radiography, positive contrast sialography, ultrasonography and computed tomography (CT) scan (Kwon et al., 2009; Suh et al., 2015). Moreover, cytology and histological examination are needed for a definitive diagnosis. Sialoliths are mostly composed of minerals such as calcium carbonate and calcium phosphate. The parotid gland is the most affected in dogs, and typically has a unilateral presentation (Trumpatori et al., 2007). One case of non-mineral sialoliths with sialoceles in both mandibular salivary glands has been reported in a dog (Suh et al., 2015). Previously, reports on sialoceles in dogs commonly described an intermandibular swelling detected through physical examination, but the specific origin, whether from one or both mandibular salivary glands, was often not identified. Additionally, these reports did not consistently find sialoliths associated with sialoceles (Cinti et al., 2021). Therefore, a comprehensive exploration of sialoliths in conjunction with sialoceles is crucial for advancing our understanding in this field and warrants further study. The standard treatment of sialoliths and sialoceles is by surgical removal (Ritter et al., 2006; Kwon et al., 2009; Suh et al., 2015; Han et al., 2016). So, this study describes and illustrates the usefulness of a CT scan in the diagnosis and treatment plan of canine sialoliths and sialoceles.

CLINICAL HISTORY AND SYMPTOMS

A 10-year-old, 8-kg, intact male, mixed-breed dog with recurring swelling in the submandibular area was sent to the Prasu-Arthorn Animal Hospital at Mahidol University for evaluation (Figure 1A). The characteristics of the mass were painless, unbruised, soft, fluctuant and ovoid, with a size of 10.3 x 6.8 x 6.3 cm in diameter. The patient's vital signs appeared within normal limits, and no significant abnormality was observed through the oral examination. A complete blood count revealed mild leukocytosis. The enlargement of the submandibular lymph nodes and submandibular salivary glands could not be assessed due to the excessive swelling at the neck.

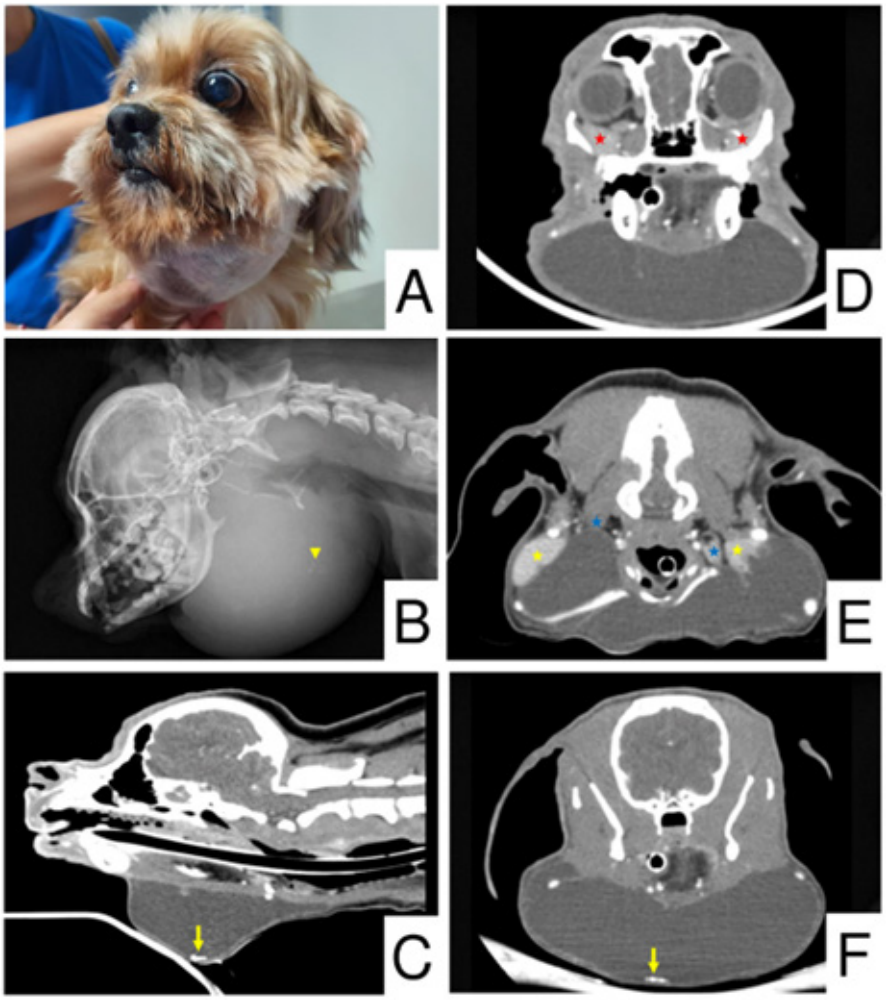

Figure 1 Sialocele lesion and radiographic imaging findings, (A); Swelling at the ventral neck, (B); Lateral radiograph of the skull shows a large, soft tissue, mineralized mass at the submandibular region. The yellow head arrow displays a few radiopaque spots. (C-F); A CT scan shows a sagittal and transverse views of the skull. (D); The red stars indicate the anatomical location of the zygomatic salivary gland, which is considered to be within normal limits. (E); The blue stars indicate the anatomical location of the mandibular lymph node while the yellow stars indicate the anatomical location of the retropharyngeal lymph node, which are considered to be within homogeneous enhancement. (D) and (F); The yellow arrows indicate the presence of hyper-attenuated materials

DIAGNOSIS AND TREATMENT

On the lateral radiograph of the skull, a large soft tissue mass (8x6 cm) with a mild degree of mineralization in the submandibular region was revealed (Figure 1B). Approximately 300 ml of yellow, viscous mucus fluid was retrieved from fine needle aspiration (FNA). Based on the location and cytological examination, the mass was highly suggestive of an inflammatory sialocele. The fluid was submitted for routine bacterial culture with the result showing no bacterial growth. Nonsurgical treatment was chosen as the primary treatment option, due to the owner's concerns about the risks associated with performing general anesthesia. At this time, the sialocele was drained, and carprofen (4.4 mg/kg; Rimadyl®, Pfizer Thailand Ltd., Bangkok, Thailand) was administered perorally once daily for one week. However, the swelling recurred after a week post-treatment, and an additional 300 ml of fluid was retrieved through aspiration. Based on the bacterial culture results, a second decompression was performed, and the dog was discharged for home nursing care for the weekend with 0.5 mg/kg prednisolone (0.5 mg/kg; Olan®, Olan-Kemed Co., Ltd., Bangkok, Thailand) orally once daily. At this time, the dog exhibited signs of improvement, and the administration of the anti-inflammatory drug prednisolone, at a dosage of 0.5 mg/kg, was sustained for one week. Unfortunately, during the subsequent two weeks, the dog lost the following two-week period due to owner non-compliance. In the fourth week, the swelling reoccurred although at a slower rate, and a lower amount of fluid was aspirated (150 ml). Because of the owner's apprehensions regarding the potential risks associated with administering general anesthesia, the dosage of prednisone was raised to 1 mg/kg once daily for a duration of two weeks, but unfortunately, no improvement was observed.

The non-invasive treatment plan through medication and decompression was proven to be unsuccessful. As a result, the owner consented to the surgical removal of the sialocele. Seven weeks following the initial visit, a CT scan was conducted to determine the structure and location of the mass in the dorsal cervical area. Following general anesthesia, the patient was intubated and maintained with isoflurane (ATTANE™; Piramal Critical Care, Inc, USA). The dog was positioned in sternal recumbency and underwent a 1.25 mm helical CT scan with a reconstructed 0.625 mm technique. Both pre- and post-contrast enhancement CT of the skull was performed. A standardized dose of iodinated contrast medium, iopamidol (2 ml/kg; Niopam® 340, Bracco UK Ltd, UK) was administered intravenously for post-contrast CT scanning. All acquired images were performed using multiplanar reconstruction to ensure the best visualization and symmetry of the mass. On both pre-and post-contrast enhancement of multiplanar reformatted images, a large well-defined hypo-attenuated mass filled with a large amount of fluid consistent with a mild degree of hyper-attenuated material attached at the wall mass was revealed at the submandibular area. The large mass deviated and compressed the adjacent organs and vessels, including the maxillary and linguofacial veins. Both medial retropharyngeal lymph nodes displayed enlargement and exhibited homogeneous contrast enhancement. Although the mass was enhanced peripherally, the central attenuation remained unchanged with Hounsfield units (HU) between pre- and post-contrast at figures of 1–15 HU, indicating compartmentalized fluid. The mass was located at the front of both submandibular salivary gland remnants, fusing to form a large sac, and

displacing large vessels, including the maxillary and linguofacial veins. Both medial retropharyngeal lymph nodes showed enlargement with homogeneous enhancement, along with a few hyperintense structures at the ground-gravity width of the sialocele edge on both sagittal views (Figure 1C) and transverse views (Figure 1D-1F). Sialocele with sialoliths was the most likely diagnosis from the CT scan.

In preparation for the surgical procedures, premedication was administered intravenously with diazepam (0.3 mg/kg; diazepam; Government Pharmaceutical Organization, Thailand) followed by induction with propofol (5 mg/kg; Propofol-Lipruro: B.Braun Melsungen AG, Germany) for endotracheal tube intubation. An intramuscular injection of morphine sulfate (0.3 mg/kg; morphine sulfate injection; M&H Manufacturing Co. Ltd., Thailand) was given for analgesia, and intravenous administration of amoxicillin/clavulanic acid (20 mg/kg; Cavumox®; Siam Bheasach Co. Ltd., Thailand) was performed for antimicrobial prophylaxis. Acetate Ringer's solution was administered intravenously via the cephalic vein in the dog's front leg. The patient was intubated and maintained at an anesthetic level using inhalation of isoflurane (ATTANE™; Piramal Critical Care, Inc, USA). The surgical site was prepared by shaving and disinfecting with a 4% chlorhexidine scrub, 70% alcohol and povidone-iodine. The patient was positioned in dorsal recumbency with an initial ventral incision made through the skin and subcutaneous tissue. A blunt dissection using Metzenbaum scissors was performed to visualize the mucocele. The center of the ventral neck exhibited a soft mass, enveloped in fibrous connective tissue (Figure 2A). Bipolar electrocautery was implemented to transect the adhesive capsule and avoid damaging the vascular structure. Consequently, the mass was removed with the capsule following salivary duct ligation with a glyconate suture (Monosyn®, 3-0 metrio, Spain). Due to the tight adherence of the sialocele to the salivary glands and lymph nodes, all the attached organs were mechanically removed from the surrounding soft tissue and blood vessels. This procedure involved making an incision through the layers of the subcutaneous tissue and platysma muscle until the mandibular and sublingual salivary glands were visualized. Subsequent dissection was performed to extract the mandibular salivary gland along with its surrounding capsule. The salivary gland and duct, the associated blood vessels, and the mucocele capsule were carefully tied off using a glyconate suture (Monosyn®, 3-0 metrio, Spain). Once securely ligated, a resection was carried out along the ligated gland, duct, mucocele and blood vessels. The volume of fluid that filled the sialocele was approximately 100 ml. Numerous small-sized salivary stones (Figure 2C) were identified upon sac removal, which involved the sialocele and duct. A Penrose drain was subsequently inserted, and the superficial muscles and subcutis were closed routinely with single layer appositional patterns with a glyconate suture (Monosyn®, 3-0 metrio, Spain). To ensure unobstructed airflow, especially in light of the severe inflammation at the surgical site, the subcutaneous tissue and skin were typically sutured closed, and a tracheostomy tube was inserted. Dexamethasone (0.3 mg/kg; L.B.S. Laboratory LTD., Part, Thailand) was administered intravascularly to prevent cervical swelling. The patient was subsequently admitted to the critical care unit of the hospital for 7 days of post-operative care. The tracheostomy tube was removed approximately 5 days after surgery with no recurrence of respiratory distress. The dog was clinically normal 1 year following the surgery with no reports of any recurrence.

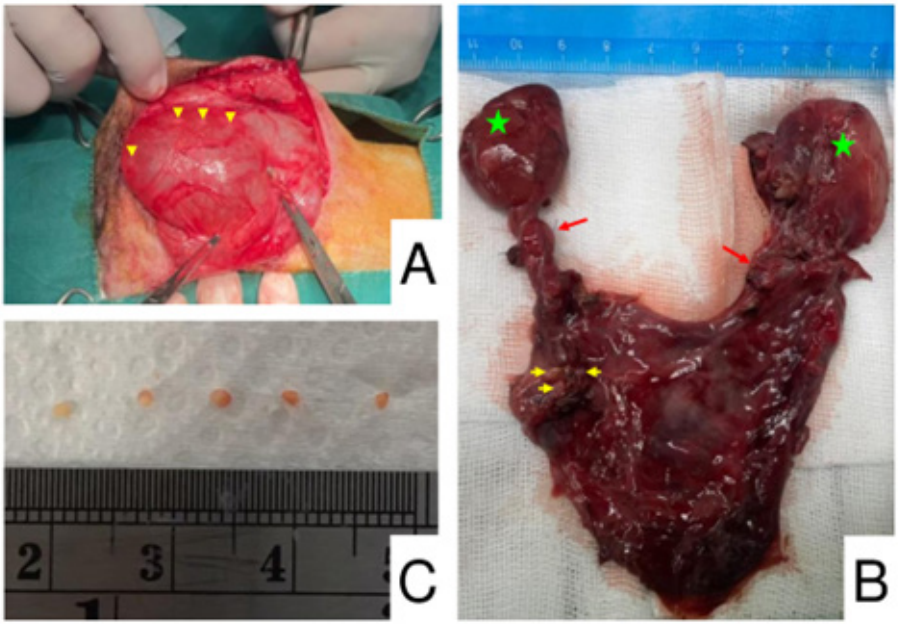

Figure 2 Submandibular sialoadenectomy, salivarectomies and lymphadenectomies procedure and macroscopic finding; (A); Sialocele between operations, Yellow-headed arrows point to siaolithiasis., (B); Submandibular sialocele, submandibular salivary glands, and submandibular lymph nodes. Red arrows point to both submandibular lymph nodes while green stars point to mandibular salivary glands. Yellow arrows point to siaolithiasis and (C); Sialolithiasis.

STONE ANALYSIS AND HISTOPATHOLOGY

In this study, Fourier-transform infrared spectroscopy (FTIR) using a Bruker Tensor 27 FT-IR spectrometer (Bruker) was employed to examine the sialoliths (Figure 2C), and the results showed the presence of proteins, triglyceride and calcium apatite with proportions of 65%, 25% and 10%, respectively. Additionally, the resected mass was submitted for histopathological examination for confirmation of a sialocele. Microscopically, the mass was encapsulated by loosely formed fibrous connective tissue with marked congestion and moderate edema. There was a lack of epithelial lining on the inner surface of the wall. Rare foci of lymphoplasmacytic infiltrates and mineralization were noted in the connective tissue. The medullary sinuses of the draining lymph node were congested, which could be due to passive congestion from vascular compression by the mass and/or inflammation. Based on these findings, this mass is most consistent with a sialocele with mild chronic inflammation.

DISCUSSION

In dogs, traumatic injuries are a common cause of submandibular mucoceles, characterized by the accumulation of saliva in the intermandibular or cranial cervical regions. Diagnosis of mucoceles and sialoliths involves various methods such as palpation, fluid analysis, cytology, radiography, ultrasonography, sialography and CT scan. The fluid obtained from a sialocele is typically a clear yellow, viscous and serosanguinous fluid (Ryan et al., 2008; Timur et al., 2022). On cytology, the fluid often contains a high amount of

background proteinaceous material, few red blood cells and salivary gland epithelial cells. Notably, they often lack mineralized bacteria, neoplastic cells or amorphous structures. A similar finding was reported by Coutin (2014) and Benjamino (2012), while another study reported the presence of inflammatory cells and amorphous mucoid substances (Kwon et al., 2009). This inflammatory response observed in sialoceles can occur in response to mechanical trauma and antigenic stimulation from the saliva. In our case, the mild chronic inflammation could also be associated with trauma from the multiple attempts at fluid drainage.

The utilization of radiographic examination for the diagnosis of head and skull conditions exhibits an important challenge. In certain instances, it is observed that plain radiography may exhibit limitations in detecting radiopaque particles due to the superimposition of multiple organs in that region. A better visualization of the head and cervical regions can be demonstrated with a CT scan. The HU range in a CT scan provides a comprehensive explanation of each aspect of capsule formation, specifically highlighting mineralization with a HU value exceeding 100 as well as the accumulation of non-enhancing low-density fluid with a HU range between 0 and 20. In cases of suspected sialocele, assessing its location and the condition of adjacent salivary glands is crucial. The density of the salivary gland, as observed in the CT scan, may appear normal or exhibit variations, such as fatty infiltration or the presence of fluid pockets. These findings, along with accompanying signs such as fat stranding, can assist in pinpointing the salivary gland associated with the sialocele. The need for advanced imaging before surgery is supported by recent research on variations in mandibular salivary glands (Durand et al., 2016). Moreover, the use of cross-sectional imaging to define abnormalities such as sialocele and to detect other organs around the lesion helps plan the intervention and treatment options (Lee et al., 2014; Tan et al., 2022). Due to the presence of a sizable cervical mucocele in this case, a CT scan proved valuable in delineating the displacement of major vessels, such as the maxillary and linguofacial veins. This imaging modality played a crucial role in identifying the specific salivary gland associated with the sialocele and facilitating the development of a highly effective surgical plan.

The management of sialocele necessitates tailoring the treatment approach in accordance with the identified underlying cause. For instance, in the case of an infection, the appropriate course of action would involve the administration of antibiotics. Relying solely on drainage as a treatment for sialocele was marked by a significant recurrence rate (Glen, 1972). Furthermore, the repetition of drainage procedures or the introduction of cauterizing or anti-inflammatory agents not only has proven ineffective in resolving the mucocele, but also introduces complications to the subsequent surgical procedure, potentially leading to abscess formation or fibrosis (Hedlund and Fossum, 2007). Similarly, if the condition is identified as a tumor or a sialolith, surgical intervention would be the recommended treatment approach. (Trumpatori et al., 2007; Timur et al., 2022). Moreover, recurrent canine sialadenitis with salivary calculi is typically unresponsive to medication (Trumpatori et al., 2007; Tan et al., 2022). In this case, the combination of fluid drainage and medication, which includes non-steroidal anti-inflammatory drugs and corticosteroids, proved to be an unsuccessful treatment, resulting in the recurrence of sialocele. The best option for removing a salivary stone and

sialocele is through conventional surgery using sialoadenectomy and surgical excision of the mucocele, which frequently demonstrate complete healing without any recurrences (<3.5%) (Termote, 2003; Ryan et al., 2008; Coutin et al., 2014). Moreover, the lateral paramedian approach was associated with a lower risk of wound-related complications compared to the ventral paramedian approach. (Cinti et al., 2021). Post-surgical submandibular swelling is a common postoperative complication with neck surgery (Benjamino et al., 2012). This can result in compression of the upper trachea, airflow obstruction and respiratory distress. In this case, the surgical exploration involved intense mechanical manipulation of the organs around the salivary sac, which can stimulate a severe inflammatory response. Thus, tracheostomy and placement of a passive drain were performed to prevent respiratory distress and minimize inflammation at the surgical site (Nicholson and Baines, 2010). The results of this study suggest that the traditional approach to treating mandibular sialocele by surgical removal led to a successful outcome, with no reported complications such as bleeding, pharyngitis, ulceration or the recurrence of the mucocele within 1 year after surgery.

The findings of the histopathological examination confirmed the diagnosis of sialocele that likely occurred secondary to the sialolith formation. The occurrence of mandibular and sublingual sialoliths is rare in dogs (Ritter et al., 2006; Cinti et al., 2021). Common locations of canine sialoliths are the parotid salivary gland, sublingual salivary gland, zygomatic salivary gland and palatal mucocele (Tivers and Moore, 2007; Trumpatori et al., 2007; Ryan et al., 2008; Kwon et al., 2009; Lee et al., 2014). Sialolithiasis was reported in only one dog with mandibular mucocele, and the type of stone was not analyzed (Suh et al., 2015). In the veterinary field, the majority of sialoliths are composed of inorganic matter such as calcium carbonate, calcium phosphate, magnesium carbonate and magnesium ammonium phosphate (Termote, 2003; Trumpatori et al., 2007; Ryan et al., 2008; Han et al., 2016). Only one reported case of canine sialoliths was demonstrated to contain 100% organic matter from the protein produced by the mandibular salivary gland (Suh et al., 2015). Interestingly, a mixture of mostly organic and some inorganic components was found in this case, based on the analysis of the stone.

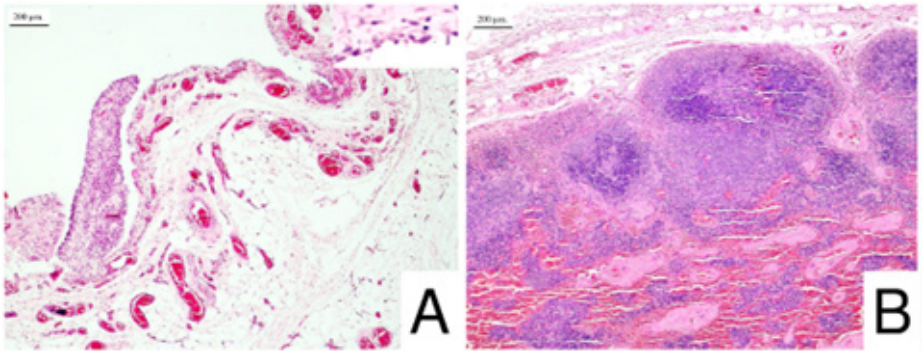

Figure 2 Histopathologic finding; (A); The wall of the salivary mucocele is congested and comprised of loosely formed, fibrous connective tissue. The surface is often denuded, with occasional lining by flattened epithelium (inset) (H&E stain, bar=200 µm). (B); The draining lymph node is reactive, with blood-filled medullary sinuses (H&E stain, bar=200 µm).

CONCLUSIONS

This case report highlights the diagnosis and treatment of an unusual recurrence of mucocele with sialolithiasis in a dog. In our findings, we suggest that medical management involving repeated drainage, or the injection of cauterizing or anti-inflammatory agents may not effectively eliminate mucoceles. Moreover, such interventions could complicate subsequent surgery by potentially leading to fibrosis. The successful management of this condition involved the use of a CT scan to assist with the treatment plan, and surgical intervention of bilateral mandibular sialoadenectomy, removal of the mucocele and submandibular lymph nodes. There was no recurrence observed after one-year post-surgery. The remarkable outcome of this case shows the importance of diagnosis and prompt intervention in managing uncommon salivary gland disorders.

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AUTHOR CONTRIBUTIONS

S.P. conceived and designed the study. S.P., S.K.1, S.S. and S.M. performed surgery. P.S. analyzed the histopathological results. S.K.2 analyzed the CT results. S.P., S.K.1 and P.S. drafted the manuscript. S.P., S.K.1 and S.M. finalized the manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this report.

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