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Clinical Paper
Clinical pathology

Clinical features of tumours and tumour-like pathologies involving the buccal fat pad

Y.-B. Li[a,b,1], H.-S. Ma[a,b,1], Z.-P. Sun[a,b], G. Li[a,b], L.-S. Sun[b,c]

[a]Department of Oral and Maxillofacial Radiology, Peking University School and Hospital of Stomatology, Haidian District, Beijing, PR China; [b]National Engineering Laboratory for Digital and Material Technology of Stomatology and Beijing Key Laboratory of Digital Stomatology, Haidian District, Beijing, PR China; [c]Key Laboratory of Oral Pathology, School and Hospital of Stomatology, Peking University, Haidian District, Beijing, PR China

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Abstract. This study aimed to investigate the clinical, radiological, and pathological characteristics of pathologies involving the buccal fat pad (BFP) and to explore the treatment protocols. The cases of 109 patients with primary pathologies involving the BFP (pBFP) diagnosed between January 2013 and September 2021 were assessed. The patients' clinical presentations and radiological and histopathological findings were analysed retrospectively, and their treatment outcomes were evaluated. The 109 pBFP were categorized as benign tumours (n = 17), malignant tumours (n = 29), vascular malformations (n = 38), and inflammatory masses (n = 25). Of the 17 benign tumours, seven were lipomas, five were pleomorphic adenomas, three were solitary fibrous tumours, and two were other tumours. The 29 malignant tumours included five adenoid cystic carcinomas, six mucoepidermoid carcinomas, three synovial sarcomas, and 15 other tumours. Of the 38 vascular malformations, 37 were venous and one was arteriovenous. Regarding the inflammatory masses, the lesions appeared after cosmetic facial botulinum toxin injection in 13 cases and after other cosmetic facial procedures in five. The upper body of the BFP was the most frequently involved site (79/109), while other frequently involved sites were the lower body (67/109) and the masseteric (41/109), temporal (32/109), and pterygopalatine (30/109) extensions.

Keywords: Neoplasms; Vascular malformations; Salivary gland neoplasms; Pathology; Radiology.

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The buccal fat pad (BFP) was first described as the molar gland by the German anatomist and surgeon Lorenz Heister in 1727.[1] It was named Bichat's fat pad in 1802. During the 1980s and 1990s, the BFP was considered an encapsulated pad of interstitial fat tissue between the anterior part of the masseter muscle and buccinator muscle.[2–4] It is currently considered an independent functional adipose structural organ that fills multiple facial spaces.[3,5,6] Although it is mainly composed of adipose tissue, the BFP has an intrinsic enveloping capsule with ligaments and vascular supply to form an independent organ.[4,5] The BFP performs important functions such as serving as a gliding cushion during mastication and contractions of the mimetic muscles.[7] It also has a

[1] Yu-Bing Li and Hua-Sen Ma are co-first authors.

prominent influence on facial aesthetics and plastic surgery.[8] The BFP flap is also used for the surgical repair of oral defects.[9–12]

Current understanding of the anatomy of the BFP is mainly based on the contributions of Kahn et al.[13] in 2000 and Zhang et al.[5] in 2002. Zhang et al. divided the BFP into anterior, intermediate, and posterior lobes, in which the posterior lobe was subsequently described as a body with four processes, namely the buccal process, pterygopalatine process, pterygoid process, and temporal process. On the other hand, the definition of Kahn et al. corresponded to the posterior lobe in the definition of Zhang et al., in which the BFP was divided into upper and lower bodies separated by the Stensen duct and six extensions, namely the masseteric, pterygopalatine, lower orbital fissure, pterygomandibular, superficial temporal, and deep temporal extensions. The 'lower body' of the BFP below the Stensen duct described by Kahn et al. corresponds to the 'buccal process',[8] while the masseteric extension could also be considered as a part of the buccal process. In later reviews, the BFP has frequently been described as consisting of a main body and buccal, pterygoid, pterygopalatine, and temporal extensions,[11,12,14] which are basically in accordance with the description of Zhang et al. of the posterior lobe of the BFP.

Despite the extensive literature characterizing the BFP and its anatomy, the pathologies involving the BFP (pBFP) have not been fully described. Lipomas, liposarcomas, hemangiomas, and vascular malformations are the most frequent neoplasm pathologies according to the literature.[15–21] Lipogranulomas of the BFP have been reported, which have usually appeared after facial cosmetic injections.[22,23] Traumatic BFP herniations are also common in children.[24–26] Computed tomography (CT) or magnetic resonance imaging (MRI) will provide an accurate locational diagnosis of pBFP. Therefore, the aim of this study was to clarify the disease spectrum and clinical characteristics of pBFP.

Materials and methods

Clinical information

This study included 109 patients (73 female, 36 male) who presented to Peking University School and Hospital of Stomatology with pBFP between January 2013 and September 2021. The patients' medical history, chief complaints, clinical presentation, treatments, histopathology findings, and follow-up were analysed. The histopathological results were reassessed according to the World Health Organization classification of bone and soft tissue tumours (WHO Classification of Tumours, fifth edition).[27]

Radiological examinations and interpretation

Plain and intravenous contrast-enhanced CT scans (GE Optima CT520Pro; GE HealthCare, Chicago, IL, USA) of the oral and maxillofacial region were performed for the 109 patients, with the following spiral CT scanning parameters: voltage 120–140 kV, current 200–380 mA, scanning and reconstruction thickness 1.25 mm, pitch 1.625:1. The contrast medium (iopamidol: 370 mg I/100 ml, 1.5–2 ml/kg) was injected at a rate of 2.0 ml/s via the ulnar vein. All images were reconstructed with standard and bone algorithms and archived in the picture archiving and communication system (PACS).

Two oral and maxillofacial radiologists with more than 10 years of clinical experience, who were blinded to the clinical information, interpreted all of the images in consensus on high-resolution screens. Linear measurements of the maximum anterior–posterior, superior–inferior, and medial–lateral diameters of the pBFP were obtained, and CT attenuations of regions of interest (ROI) inside the lesions were measured, with the ROI drawn as large as possible in the solid part of the neoplasms. Imaging findings included vascular enhancement, phleboliths, liquefactive necrosis, degenerative cyst, and involvement of the surrounding bone structures, such as the posterolateral wall of the maxillary sinus, orbit, sphenoid bone, and mandibular ramus. The BFP structure was classified into upper body, lower body (buccal process), masseteric extension, pterygopalatine extension, pterygomandibular extension, lower orbital fissure extension, and temporal extension for analysis (Fig. 1; Supplementary Material Figs. S1–S7, Supplementary Material Table S1). The lesions were also categorized as small-sized (≤2.0 cm), medium-sized (2.0–4.0 cm), or large-sized (> 4.0 cm) for analysis.

Results

Of the 109 pBFP, 17 were benign tumours, 29 were malignant tumours, 38 were vascular malformations, and 25 were inflammatory masses. The pathological classifications of the benign and malignant tumours are listed in Table 1. Clinical details of the pBFP are given in Supplementary Material Table S2. The upper body was most frequently involved (79/109), while the lower body (67/109) and the masseteric (41/109), temporal (32/109), and pterygopalatine (30/109) extensions were also frequently involved.

Benign tumours

Benign tumours were observed in 17 patients (12 female, five male) aged between 7 and 69 years (mean age 42.4 years). They were all unilateral (10 left, 7 right). The symptoms included a painless mass in the buccal (12/17) or temporal (4/17) region; the mass was an incidental finding on imaging in one asymptomatic case. The pathological diagnoses included lipoma ($n = 7$), pleomorphic adenoma ($n = 5$), solitary fibrous tumour ($n = 3$), schwannoma ($n = 1$), and nodular fasciitis ($n = 1$).

The benign tumours were small-sized (1/17) or medium-sized (8/17) lesions involving only one part, or large-sized lesions (8/17) involving one to six parts. The primary original site was the upper or lower body in 15 cases, the masseteric extension in one case, and the temporal extension in one case. In 10 cases, the tumours were round or oval and localized in the primary original sites (Fig. 2). The large-sized tumours originating from the upper and lower bodies of the BFP could also irregularly spread to the adjacent extensions. The lipomas, solitary fibrous tumours, and schwannoma showed growth potential involving multiple parts of the BFP (Fig. 3).

The tumours were well-demarcated, and their shape was regularly round and oval or showed irregular protrusions. CT values on the plain and enhanced CT scans showed specificity for the diagnosis of lipomas and solitary fibrous tumours. The lipomas showed specific fat tissue attenuation (−118 HU to −92 HU) with little enhancement (−110 HU to −79 HU), while the

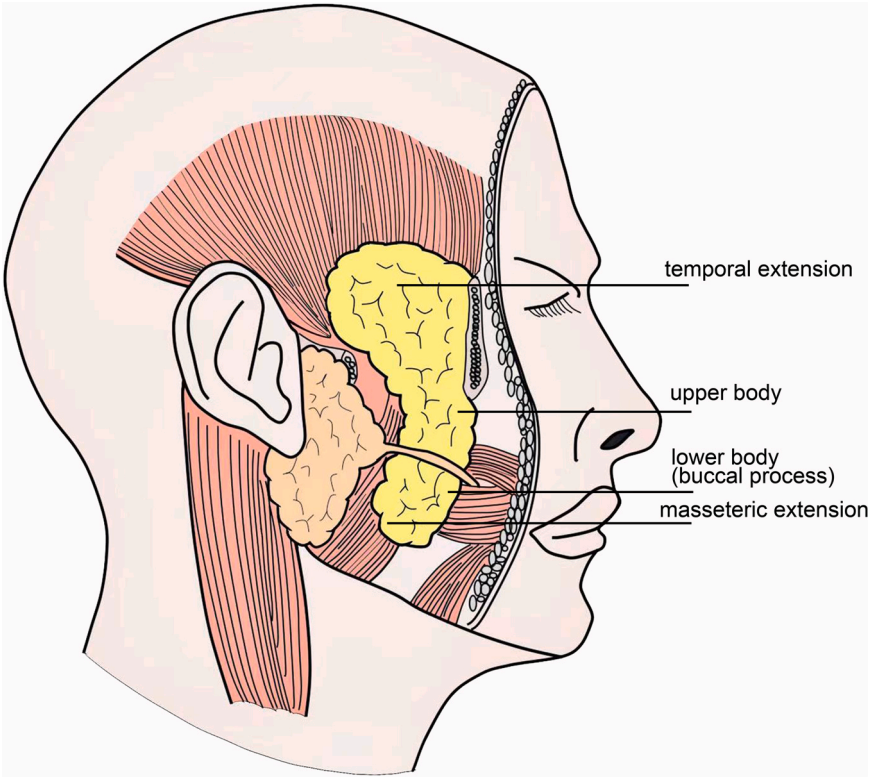

Fig. 1. Schematic lateral view of the buccal fat pad. The lower body, also known as the buccal process, is located below the Stensen duct, anterior to the masseter and beneath the buccal mucosa. The lower body extends backwards to form the masseteric extension superficial to the masseter. The upper body is located superior to the Stensen duct, posterior to the maxillary sinus wall. The upper body extends upwards, superficial and deep to the temporalis, to form the temporal extension.

solitary fibrous tumours showed homogeneous soft tissue attenuation (40–49 HU) and remarkable enhancement (194–347 HU) (Fig. 3). The pleomorphic adenomas showed soft tissue attenuation (30–56 HU) and slight enhancement (70–94 HU) (Fig. 2), while the schwannoma showed heterogeneous soft tissue attenuation (34 HU) with degenerative cysts and slight progressive enhancement (arterial phase, 68 HU; intravenous phase, 80 HU). Solitary fibrous tumours showed thinning and depressed curved deformation of the posterior maxillary sinus wall, depressed deformation of the coronoid process of the mandible (Fig. 3), or widening of the inferior orbital fissure and optic canal (2/17). The schwannoma showed intraosseous growth potential with involvement of the sphenoid bone or posterior wall of the maxillary sinus.

Radical surgical excision was performed in 15 cases (one small tumour, seven medium-sized tumours, and seven large tumours). Biopsy was performed in one patient. Intraoral incisions were used when the lesion was localized in the upper or lower body (9/17). A temporal pre-auricular incision was used when the lesion primarily involved the temporal extension (1/17). A Weber–Fergusson incision (2/17) or mandibular osteotomy via lower-lip and submandibular incisions (3/17) was used when the tumour had become extremely large or involved multiple BFP compartments in the infratemporal fossa.

Recurrence was observed in a large solitary fibrous tumour at 30 months of follow-up. No recurrence occurred in the other patients over a follow-up

Table 1. Tumours of the buccal fat pad and pathological classifications.

Origin tissue	Classifications	Pathological diagnoses (*n*)
Connective tissue	Adipocytic tumours	Lipoma (7)
	Tumours of vascular origin	Epithelioid angiosarcoma (1)
		Epithelioid hemangioendothelioma (1)
	Fibroblastic and myofibroblastic tumours	Solitary fibrous tumour (3)
		Nodular fasciitis (1)
	Chondro-osseous tumour	Extraskeletal osteosarcoma (1)
	Haematopoietic tumour	Lymphoma (1)
Salivary tissue	Epithelial tumours	Pleomorphic adenoma (5)
		Adenoid cystic carcinoma (5)
		Mucoepidermoid carcinoma (6)
		Myoepithelial carcinoma (1)
		Ductal carcinoma (1)
		Acinic cell carcinoma (1)
		Polymorphous adenocarcinoma (1)
Other tissue	Tumours of striated muscle	Rhabdomyosarcomas (2)
	Peripheral nerve sheath tumours	Schwannoma (1)
	Tumours of uncertain differentiation	Synovial sarcoma (3)
		Undetermined sarcoma (5)

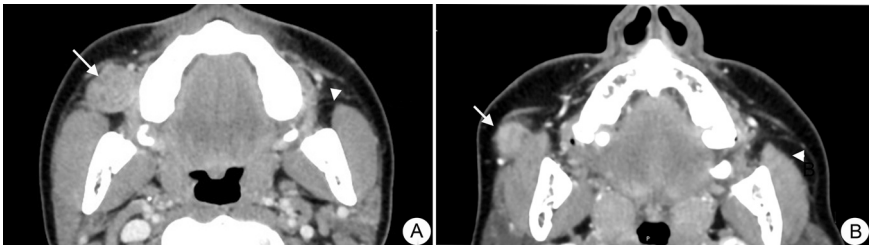

Fig. 2. Pleomorphic adenomas (white arrows) in the lower body (A) and masseteric extension (B) of the BFP. The latter (B) is easily confused with those from the accessory parotid gland. The normal lower body (A, arrow head) and masseteric extension (B, arrow head) are marked on the contralateral normal side.

period ranging from 2 to 36 months (mean 11.5 months).

Malignant tumours

Twenty-nine patients (14 female, 15 male) aged between 4 and 71 years (mean age 43.4 years) were diagnosed with malignant tumours. In all 29 cases, the tumours were unilateral (14 left, 15 right). Five were adenoid cystic carcinomas, six were mucoepidermoid carcinomas, three were synovial sarcomas, and 15 were other tumours (Table 1). The symptoms included facial swelling (14/29), mouth-opening limitations (11/29), pain (15/29), and other discomfort (3/29). The maximum tumour diameter ranged from 2.1 cm to 9.9 cm (mean 4.7 cm). The tumours most frequently originated from the upper or lower body of the BFP (23/29) (Fig. 4).

The borders of the lesions were ill-defined in 20 cases and well-defined in nine cases. Regarding the CT values, the tumours showed moderate or marked enhancement (Fig. 4). Calcification was observed in two of the three cases of synovial sarcoma, one case of rhabdomyosarcoma, and one case of ductal carcinoma. Compressive changes of the adjacent bones included thinning or curved depression of the posterior maxillary wall (19/29), the ramus (2/29), the zygomatic arch (2/29), and the greater wing of the sphenoid (2/29). Other changes included destruction of the posterior wall of the sinus (6/29), erosion of the ramus (4/29), and destruction of the pterygoid process of the sphenoid (7/29).

An incisional biopsy was performed in 10 patients before surgery. Surgical excision was performed by intraoral incision (3/29), Weber–Fergusson incision (5/29), or mandibular osteotomy with lower-lip and submandibular incision (13/29). Maxillectomy was performed in six patients. Neck dissection was performed in eight patients: two with mucoepidermoid carcinoma, two with adenoid cystic carcinoma, one with acinic cell carcinoma, one with synovial sarcoma, one with polymorphous adenocarcinoma, and one with undetermined sarcoma. Postoperative radiotherapy was performed in 13 patients: five with adenoid cystic carcinoma, three with synovial sarcoma, four with mucoepidermoid carcinoma, and one with polymorphous adenocarcinoma. One patient with myoepithelial carcinoma (intraoral incision) showed recurrent tumour at 28 months. No recurrence was noted in the other patients over a follow-up period ranging from 1 to 5 years (mean 2.3 years).

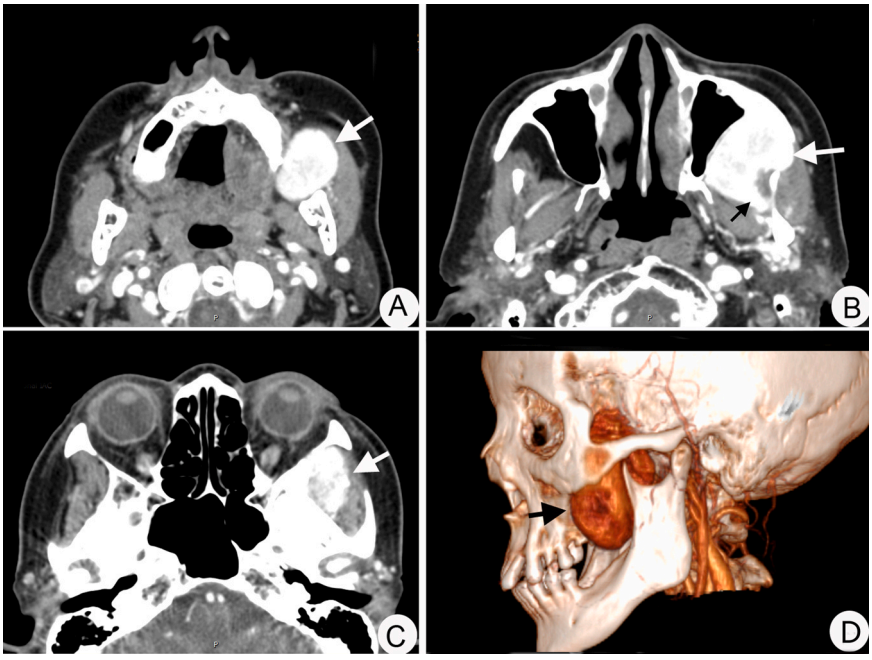

Fig. 3. Enhanced CT images showing a solitary fibrous tumour of the BFP extending from the lower body (A) and upper body (white arrow, B) to the pterygomandibular extension (black arrow, B) and deep temporal extension (white arrow, C). Three-dimensional imaging showing the tumour extending from the buccal process to the temporal region (D).

Vascular malformations

Vascular malformations were diagnosed in 38 patients (22 female, 16 male) aged between 6 and 73 years (mean age 42.3 years). There were 37 cases of venous malformation and one case of arteriovenous malformation. All were unilateral (15 left, 23 right). The symptoms included buccal (30/38) or temporal (2/38) masses, and occasional spontaneous pain (7/38); the mass was an incidental finding on imaging in four asymptomatic cases. The postural test was positive in five patients.

The vascular malformations were small-sized in six cases, medium-sized in 25 cases, and large-sized in seven cases. The maximum diameter ranged from 1.4 cm to 5.3 cm (mean 3.1 cm). Most of the vascular malformations showed soft tissue attenuation with well-defined (31/38) or ill-defined (7/38) borders; three of the seven ill-defined cases presented a grid shape and structure. Phleboliths (15/38) and vascular enhancement (22/38) were observed (Fig. 5). The plain CT values ranged from 23 HU to 62 HU (mean 46.7 HU), and enhanced CT values from 40 HU to 163 HU (mean 63.9 HU).

Puncture examinations were performed to obtain venous blood in two

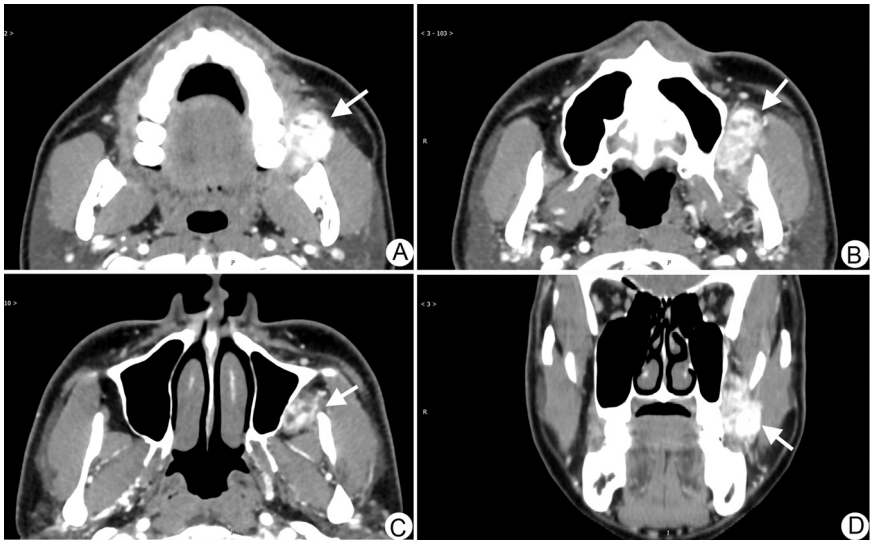

Fig. 4. Mucoepidermoid carcinoma affecting the lower body (A) and upper body (B–D) of the BFP.

cases. Twelve of the 38 patients underwent excision via intraoral ($n = 9$) or facial ($n = 3$) incision. Sclerotherapy with bleomycin injection (18/38), sclerotherapy with subsequent surgical resection (1/38), or follow-up observation (7/38) was performed in clinically diagnosed cases. No postoperative recurrence was observed over 1–4 years of follow-up.

Inflammatory lesions

Inflammatory lesions were diagnosed in 25 female patients aged 22–48 years (mean age 36.8 years). Nine bilateral and 16 unilateral cases were included. Clinical presentations included recurrent buccal swelling (24/25) and spontaneous facial pain (10/25). A medical history of a cosmetic procedure was observed in 18 patients, including facial autologous fat injections in four, facial botulinum toxin injection in 13, and liposuction in one. An odontogenic or glandular infection was confirmed in four patients. The etiological cause could not be specifically confirmed in three patients.

Eight of the lesions were small-sized, 23 were medium-sized, and three were large-sized. The maximum diameter ranged from 1.1 cm to 4.9 cm (mean 2.72 cm). The inflammatory lesions tended to show diffuse involvement of multiple parts, with primary involvement of the upper body (19/34), lower body (17/34), masseteric extension (4/34), and lower orbital fissure extension (1/34). Secondary involvement affected the upper body (9/34), lower body (10/34), masseteric extension (18/34), pterygopalatine extension (6/34), and lower orbital fissure (1/34). Most of the inflammatory lesions tended to show irregular shapes with ill-defined borders and a grid texture and enhancement (Fig. 6). Destruction of the adjacent bone was observed in only one patient.

Surgical resections were performed in 13 patients. An intraoral approach via the buccal mucosa was used in 11 patients, when the body of the BFP was mainly affected. A mandibular osteotomy via a submandibular incision was used in one patient in whom extensive parts of the BFP had been affected. A pre-auricular incision was used in one case involving the masseteric extension. None of the patients showed postoperative recurrence over 2–6 years of follow-up.

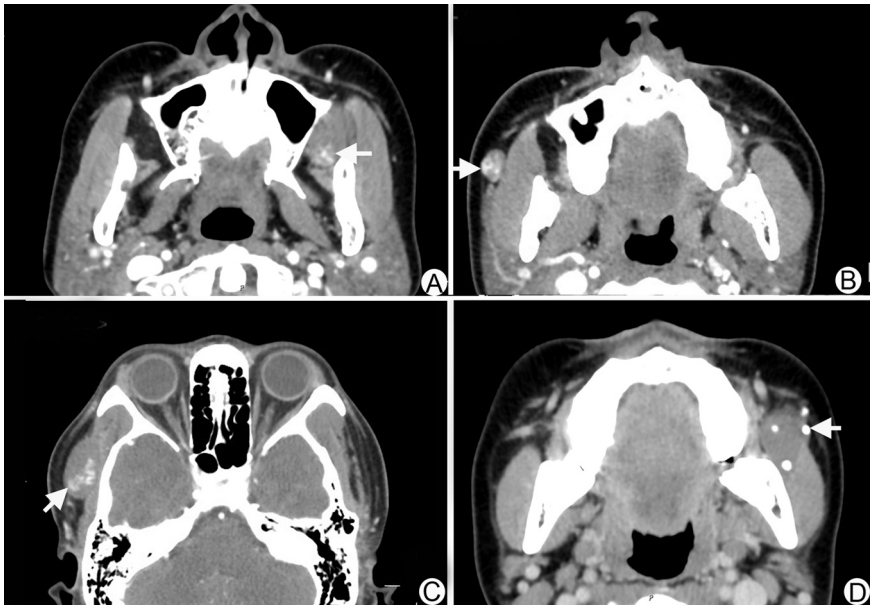

Fig. 5. Venous malformations in four patients, involving the upper body (A), masseteric extension (B), superficial temporal extension (C), and lower body (D) of the BFP. Vessel enhancement (white arrows, B–C) in the enhancement phase and phleboliths (white arrow, D) are indicative for diagnosis.

Discussion

The aim of this study was to analyse the pathologies affecting the BFP and to investigate the possible clinical diagnostic clues. The BFP covers a wide anatomical range involving the buccal space, masticatory space, infratemporal fossa, and temporal space. According to the results of the present study, some tumours that were previously assumed to have originated from the facial spaces might have arisen from the BFP.

The disease spectrum included a wide range of histological origins. Salivary tumours (20/109), lipomas (7/109), vascular malformations (38/109), and inflammatory lesions (25/109) constituted a large proportion of the pBFP

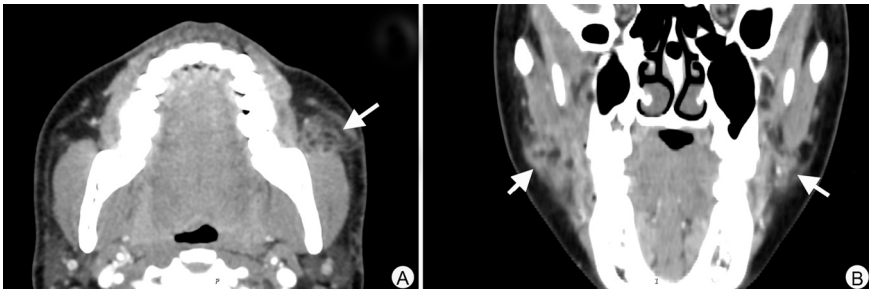

Fig. 6. Lipogranuloma in a unilateral case (A) and a bilateral case (B). The involved buccal process (A) and multiple parts of the BFP (B) were swollen with a heterogeneously enhanced grid texture.

(Table 1). Most vascular malformations were venous malformations. All of the inflammatory lesions occurred in women over 22 years of age, with 72% of cases (18/25) being in women who had undergone facial cosmetic procedures. It has been reported previously that lipomatous granulation could account for some inflammatory circumstances.[22] The cause of the inflammatory lesions could not be specifically confirmed in three cases. Inflammatory lesions affecting the BFP should be examined carefully to exclude potential causes such as odontogenic or idiopathic infection and immune diseases.

The benign tumours frequently presented as painless cheek masses without remarkable functional impairment. Mouth-opening difficulty and recurrent facial swelling might indicate a malignancy. Venous malformations showed similar clinical presentations to benign tumours. Puncture examination helped to confirm the diagnosis of vascular malformation. The patients with inflammatory lesions showed recurrent buccal swelling and spontaneous unilateral or bilateral facial pain. Some of the inflammatory cases were associated with prior facial cosmetic procedures. In cases of vascular malformations and inflammatory lesions, a surgical intervention could possibly be avoided without the need for biopsy.

Considering the high proportion of malignant tumours affecting the BFP (29 of 46 tumours; 63.0%), imaging evaluations are very important for clinical diagnosis. Cross-sectional CT and MRI scans can facilitate accurate location diagnosis of pBFP.[14,28] The CT imaging features of pBFP can help reinforce some opinions and clarify some of the confusion associated with the BFP anatomy. The upper body and lower body (buccal process) constitute nearly 50% of the volume of the BFP[14] and are most frequently involved in BFP pathologies. On the other hand, the pterygoid, pterygopalatine, temporal, masseteric, and lower orbital fissure extensions are more prone to show secondary involvement.

Benign tumours appeared as well-demarcated round or lobulated soft tissue masses. Benign tumours might give rise to compressive thinning or curved deformation of the adjacent facial bone structures such as the posterior maxillary sinus wall. Malignancies presented as poorly demarcated (26/29) or well-demarcated (3/29) lesions. Malignancies caused compressive and destructive bony changes. These findings indicate that some malignancies may present as clinically benign tumours. Venous malformations also presented with well- or ill-defined borders. The phleboliths were highly indicative of venous malformations. Inflammatory lesions usually presented as diffuse involvement of multiple sites with grid-like shapes and ill-defined borders. Similar CT presentations on both sides in cases with a history of facial cosmetic procedures might also indicate a diagnosis of inflammatory lesions.

Enhancement features on CT may be helpful for the diagnosis of some tumours. The mucoepidermoid carcinomas showed significantly greater enhancement (89–187 HU, mean 148 HU) than the other malignant tumours. CT values of approximately − 100 HU on plain CT and enhanced CT are specific for lipoma. Solitary fibrous tumours showed very specific CT values in the enhancement phase (approximately 200–300 HU), which were almost identical to those of artery vessel enhancement.[29,30] Vessel enhancement was indicative of venous malformation. Although CT imaging helps in the differential diagnosis of tumours and non-tumour pathologies, it is not fully able to identify malignancies accurately, because some malignancies present with benign clinical manifestations. Preoperative biopsy could be suggested for large-sized lesions or suspected malignant tumours.

Surgical excision is the primary treatment choice for neoplasms involving the BFP. The surgical approach depends on the location, size, and nature of the neoplasm. Imaging examinations can greatly facilitate clinical evaluation of the nature of the lesion as well as treatment planning. Sclerotherapy can also be used for the treatment of venous malformations. While an intraoral approach can be used to excise small- or medium-sized 'clinically benign' lesions, large-sized benign tumours and clinically malignant tumours can be removed using Weber–Fergusson or submandibular incisions. A partial maxillectomy or mandibulectomy may be required for complete exposure, depending on the size and location of the tumour. The surgical defects were repaired with anterolateral thigh, forearm, and iliac flaps in this series of patients. Postoperative radiotherapy and chemotherapy can be considered, depending on the results of the pathological evaluation.

Lipogranulomas are a rare complication of facial cosmetic procedures that have recently been recognized by oral and maxillofacial clinicians.[22,23] These lesions could be foreign-body reactions to exogenous lipid/oil-like substances such as paraffin or silicone, or granulomatous reactions caused by endogenous degeneration of lipids secondary to infection, trauma, extremes of temperature, or allergy.[22] In this study, various facial cosmetic procedures were shown to be associated with the BFP inflammatory lesions, including facial autologous fat injection, botulinum toxin injection, and liposuction. Lipogranulomas can be correctly diagnosed by a combination of imaging analysis with clinical examinations and medical history. Although lipogranulomas may show diffuse involvement in the BFP, the masses tend to be localized and can be

surgically removed via intraoral excision. Non-symptomatic lipogranulomas of the BFP can also be managed conservatively with close follow-up observation.

Ethics approval and consent to participate

This study was approved by the Ethics Review Committee of Peking University School and Hospital of Stomatology (PKUSSIRB-202162019).

Competing interests

None.

Patient consent

Not required.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijom.2023.03.008.

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Correspondence to: Department of Oral and Maxillofacial Radiology
Peking University School and Hospital of Stomatology
22 Zhongguancun South Avenue
Haidian District
Beijing 100081
PR China.
Tel:+86 10 82195324.
E-mail: sunzhipeng@bjmu.edu.cn