

Is the buccal compartment a masticatory space extension or an anatomic space in itself? Evidence based on medical images and human cadaver dissection

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Abstract

Objectives According to some authors, the buccal space is incompletely closed with no real anatomical separation from the masticator space, and also has no fascial limit toward the cranial and caudal regions. However, several other authors consider this anatomic area to be a separated space. The goal of this study was to provide a detailed description of the normal anatomy using medical images and human cadaveric head material dissection of this facial anatomic region, to precisely clarify its condition as an extension of the masticator space or an independent space.

Methods The buccomasseteric area in 25 male and female patients aged 14–68 years, who were referred for various head and neck disorders that did not compromise the masticatory and buccal area, was analyzed by magnetic resonance imaging on the axial and coronal planes. The region was further examined by dissection of the buccomasseteric area in four heads of fresh adult male and female human cadavers aged 30–65 years.

Results The findings demonstrated that the buccal compartment should be considered part of the masticator space, rather than a space in itself. This was mainly because a corridor was positioned medially to the tendon of the

masseter muscle that communicated the infratemporal region of the masticator space with the buccal region, with no fascial barrier at this level that could separate it from the masticator space.

Conclusions The present study suggests that the buccal compartment is part of the masticator space, rather than a space in itself.

Keywords Buccal space · Masticator space · Anatomy · Radiology

Introduction

The extracranial head and suprahyoid neck area is separated in different anatomic regions that are mainly bounded by fasciae, and well-known as “spaces”. In contemporary radiology, these spaces have been defined not only with consideration of their fascial limits, but also taking into account their anatomic contents.

The so-called buccal space is the buccal compartment (BC) of the extracranial head and neck area localized in the deep region of the face, lying adjacent to the external surface of the jaw alveolar bone. It has been considered part of the masticator space (MS) for many decades. In 1945, Kostrubala [1] subdivided the MS into different compartments, including the BC, and described their extents. However, many other researchers have described this compartment as a true space [2–8]. This issue is especially important from a radiological and clinical point of view in differential diagnosis, and also to explain the most probable pathway followed by a pathological process involving the BC in its progression through different anatomic areas.

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The BC could be considered part of the MS based on the information provided by some authors, who stated that the buccal region is an incompletely fasciae-enclosed space with no true superior and inferior boundary [7]. Furthermore, the buccal fat pad may provide a communication with the MS [7], and the parotideomasseteric fascia is incomplete along its medial course where it joins the buccopharyngeal fascia [5, 6]. However, certain issues remain unclear and confused, despite the large body of literature referring to the BC, especially its posterior, superior, and inferior boundaries that are considered important pathways for the spread of infections to and from the BC. This background highlights the necessity to obtain a comprehensive understanding of its limits to determine whether it truly belongs to the masticator spaces, and of course, to understand the pattern of pathological spreading. In this study, the medial, lateral, and anterior limits of the BC were investigated in detail.

Materials and methods

Representative magnetic resonance imaging (MRI) sections displaying the normal anatomy of the buccomasseteric region in different planes were taken from 25 informed and consenting male and female patients, aged 14–68 years, suffering from conditions referable to other anatomic regions, with the examined area reaching from the skull base to the hyoid bone.

MRI acquisitions were performed on 3 Tesla (Skyra; Siemens, Erlangen, Germany) and 1.5 Tesla (Intera; Philips Medical Systems, Best, Netherlands) MRI scanners. In the case of the 3 Tesla MRI scanner, a 32-channel phased-array head coil was used. The images utilized for the study were obtained with an axial T2-weighted sequence (repetition time/echo time, 3300/90 ms; field of view, 160 × 184 mm; matrix, 512 × 512; section thickness, 2 mm) and a coronal T2-weighted sequence (repetition time/echo time, 3730/90 ms; field of view, 160 × 184 mm; matrix, 512 × 512; section thickness, 2 mm). The axial acquisitions were made parallel to the plane of the hard palate.

For the 1.5 Tesla MRI scanner, a six-channel phased-array head coil was used. There was no standardized MRI protocol, and the examination included coronal and axial T2-weighted sequences as well as coronal and axial T1-weighted sequences.

The limits of the BC were characterized in detail, placing emphasis on the superior, inferior, and posterior boundaries. In addition, the extension and space occupying the fat pad in the area were critically analyzed, as well as how the fat pad connects with these two compartments. The buccomasseteric area was further examined by

dissection of four heads of fresh adult human male and female cadavers aged 30–65 years. The cadaveric material belonged to the Department of Normal Anatomy, Faculty of Medicine, University of Chile, and the Department of Anatomy, Faculty of Medicine, Pontifical Catholic University of Chile.

Results

BC boundaries

Medial limit In every case examined in the present study, it was clearly seen that the BC was not only limited by the buccinator muscle with its overlying fascia, which reached the premolar alveolar bone process in almost all patients, but also by the lateral aspect of the maxilla and mandible above and below the alveolar ridge, respectively. At the level of the maxilla, the canine fossa was the medial limit of the BC, including a sector of the zygomatic process. At the level of the mandible, the external bone plate constituted one part of the medial limit of the BC until the insertion of the platysma muscle on the lower border of the mandible (Figs. 1, 2a).

Lateral and anterior limits In the cases examined, an anterolateral limit was provided by the superficial layer of the deep cervical fascia, the muscles for facial expression, mostly the levator labii superioris alaeque nasi, levator labii superioris, zygomaticus minor, zygomaticus major, risorius, depressor anguli oris, and platysma, the superficial cervical fascia, the subcutaneous tissues, and the skin. Toward the posterolateral area, a limit given by the anteromedial edge of the superficial masseter was also identified, which originated on the zygomatic process of the maxilla and along the inferior border of the zygomatic bone (Fig. 2).

Superior limit This boundary was more of a superolateral border than just a superior limit. It was provided by bony and soft tissue components. Toward the anterior part, the superolateral limit was compounded by the zygomatic process of the maxilla, the zygomatic bone, and the origin of the masseter muscle at the zygomatic process of the maxilla. The limit was also marked by the anterior edge of the maxilla orbital part (corresponding to the infraorbital margin) and the corresponding muscles for facial expression originating at that level, mainly the levator labii superioris, besides the subcutaneous and cutaneous tissues. However, toward the posterior area, the BC did not have a superior limit, and communicated freely with the infratemporal fossa.

Posterior limit From lateral to medial, the BC was bounded by the anterior edge of the masseter muscle, the mandible, and the temporal and pterygoid muscles.

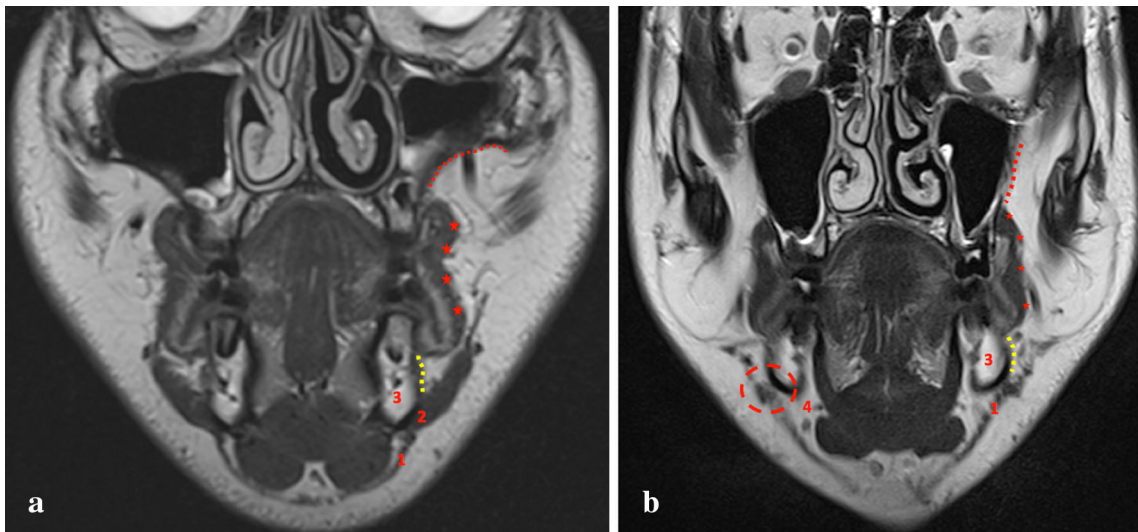


Fig. 1 **a, b** Coronal slices of T2-weighted MRI at the level of the bicuspids (**a**) and molar teeth (**b**), showing the medial limit of the BC constituted by the buccinator muscle (*stars*) and the external bone plate of both the maxilla (*red dotted line*) and the mandible (*yellow dotted line*). The images also show the attachment of the depressor

anguli oris muscle (**a**) and the insertion of the platysma muscle (**b**) on the mandible, defining the most inferior limit of the BC. 1 Platysma muscle, 2 depressor anguli oris muscle, 3 mandible bone, 4 submandibular space. The *red dashed circle* indicates the insertion site of the platysma muscle on the mandible (**b**)

In the dissected human material, the parotideomasseteric fascia was split into a superficial leaf that extended anteriorly blending with the buccinator fascia, and a deep leaf that went around the anterior border of the masseter muscle, covering the anterior border of the mandibular ramus, and finally blending with the temporal muscle.

In addition, it was found that the buccinator muscle blended into the tendinous fascicules of the temporal muscle as it descended, inserting into the anterior border of the ramus of the mandible. Meanwhile, at the level and medial to the thick tendinous aponeurosis of the superficial portion of the masseter muscle, which arose from the zygomatic process of the maxilla, there was a direct and free communication backward and upward from the BC to the infratemporal fossa (Figs. 3, 4).

Inferior limit: This limit was better evaluated in the coronal slices. In all cases examined, the platysma muscle was seen as the inferior limit of the BC, as this muscle inserted into the inferior border of the mandible. Toward the anterior part of the BC, the depressor anguli oris muscle was also seen to contribute to the inferior limit, at which the platysma muscle converged (Fig. 1). A fascial attachment to the mandible bone under the platysma muscle was also seen in the anatomic samples, forming part of the inferior limit of the BC.

Masticatory fat pad (MFP) In the 25 individuals examined, a mass of fat related to the masticatory muscles and buccinator muscle was seen, consisting of a body and several extensions. The body of this fat was localized immediately posterior to the lateroposterior wall of the maxilla. The anterior part of the MFP body gave out a

buccal extension (buccal fat pad) that was connected by a buccal process. In every individual examined, this process reached the BC by passing through a narrow passage formed posteriorly by the ending part of the tendinous aponeurosis of the superficial portion of the masseter muscle, and anteriorly by the medial wall of the BC. It reached even the profound area of the face, passing laterally to the buccinators and deep to the muscle elevator of the upper lip and wing of the nose, the elevator of the upper lip, the lesser zygomatic muscle, and the major zygomatic muscle, extending to the canine fossa (Fig. 5).

Discussion

The anatomic soft tissue spaces in the face have been extensively studied and described by many researchers throughout a number of decades, from authors such as Coller and Yglesias [9] in 1935 and Grodinsky and Holyoke [10] in 1938 to present times [11, 12]. Nevertheless, fundamental issues about the BC still remain confused and unclear, and it is extremely important to achieve a complete understanding of this anatomic area to obtain consistent responses, including why the BC is frequently affected when there is infection or malignancy in the MS [13, 14].

One of the principle-confused issues is the inadequate understanding of its anatomy, deriving from some misconceptions regarding its limits and definition as an MS compartment or an independent space. Some authors still consider it a separate anatomic space [2, 3, 6, 15–17], even

Fig. 2 Lateral anatomic view of the buccomasseteric region of a human-dissected specimen (a) and cropped axial slices of T2-weighted MRI (b–e) showing the anterolateral limits of the BC. The posterolateral limit of the BC is also shown. 1 Levator labii superioris muscle, 2 orbicularis oculi muscle, 3 levator anguli oris muscle, 4 zygomaticus major muscle, 5 buccinator muscle, 6 masseter muscle, 7 risorius muscle, 8 depressor anguli oris muscle, 9 orbicularis oris muscle, 10 platysma muscle, 11 lateral aspect of mandible below buccinator muscle. The red dashed line indicates the anteromedial edge of the masseter muscle, which constitutes part of the posterior lateral limit of the BC (c, d)

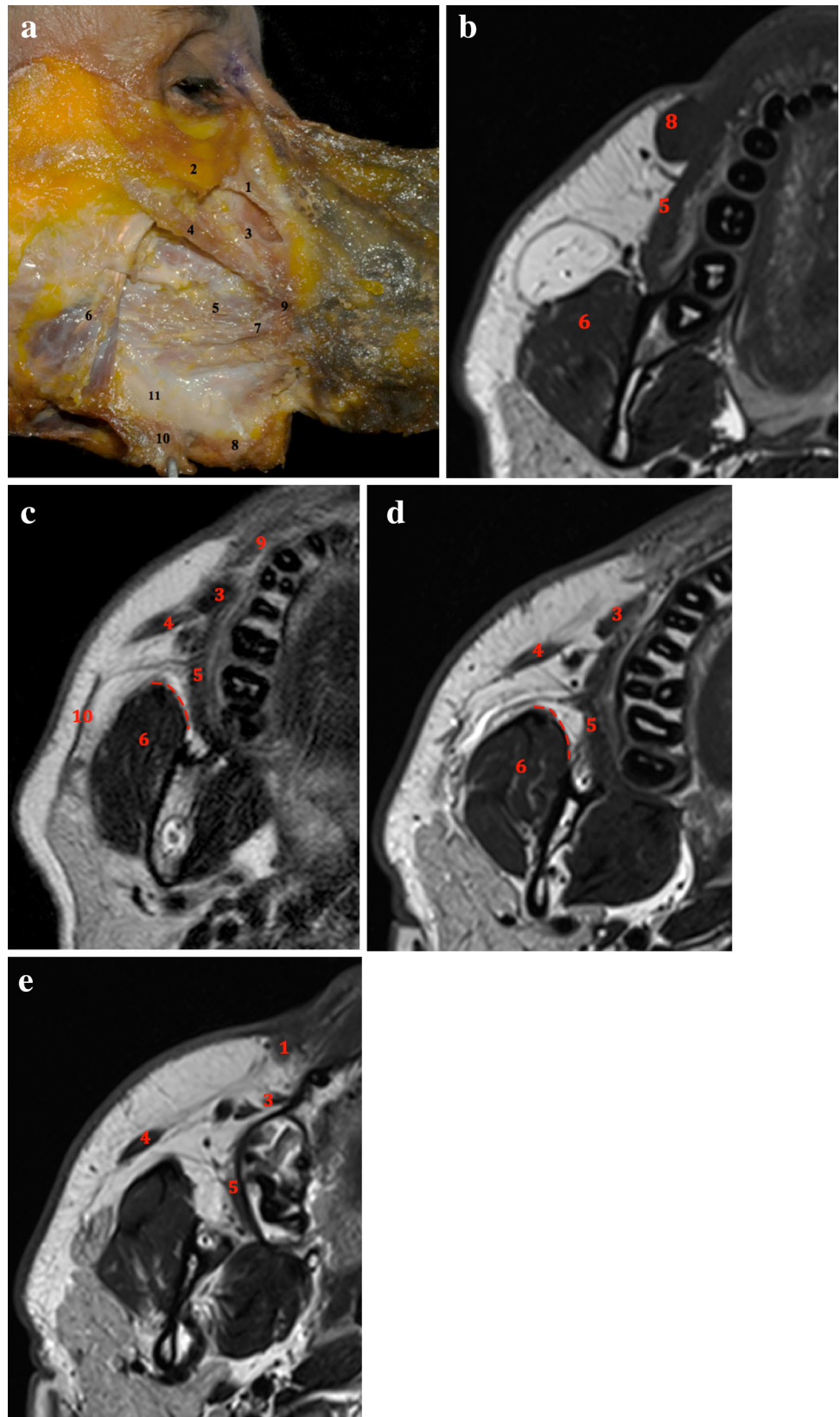


Fig. 3 a, b Lateral (a) and anterolateral (b) anatomic views of the buccomasseteric region of a human-dissected specimen, showing part of the posterior limit of the BC. 1 Anterior border of masseter muscle, 2 part of buccal fat pad emerging from infratemporal region, 3 buccinator muscle, 4 tendon of masseter muscle, 5 parotid duct, 6 anterior border of ramus of mandible

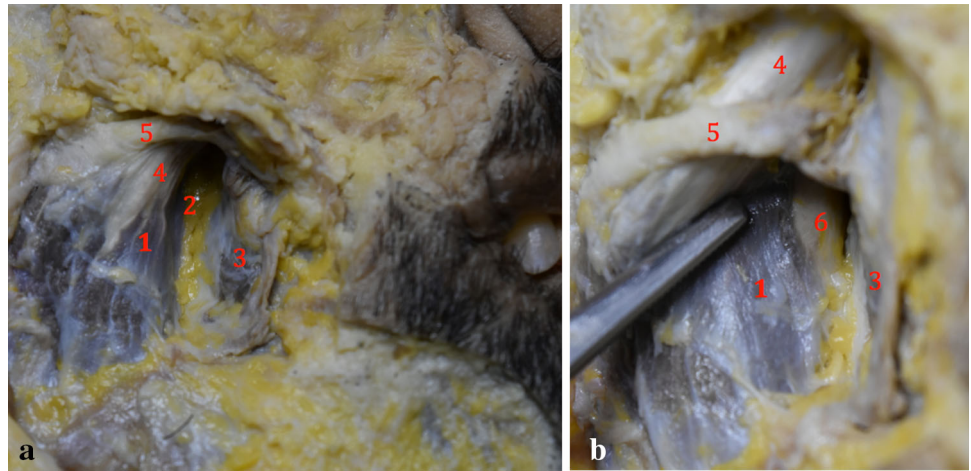


Fig. 4 a, b Detailed anterolateral anatomic view of the buccomasseteric dissected area (a) and cropped coronal slice of T2-weighted MRI (b), showing the passage from the BC to the infratemporal region of the MS (a). 1 Tendon of masseter muscle, 2 entrance to infratemporal region, 3 buccinator muscle and its fascia, 4 parotid duct, 5 masseter muscle

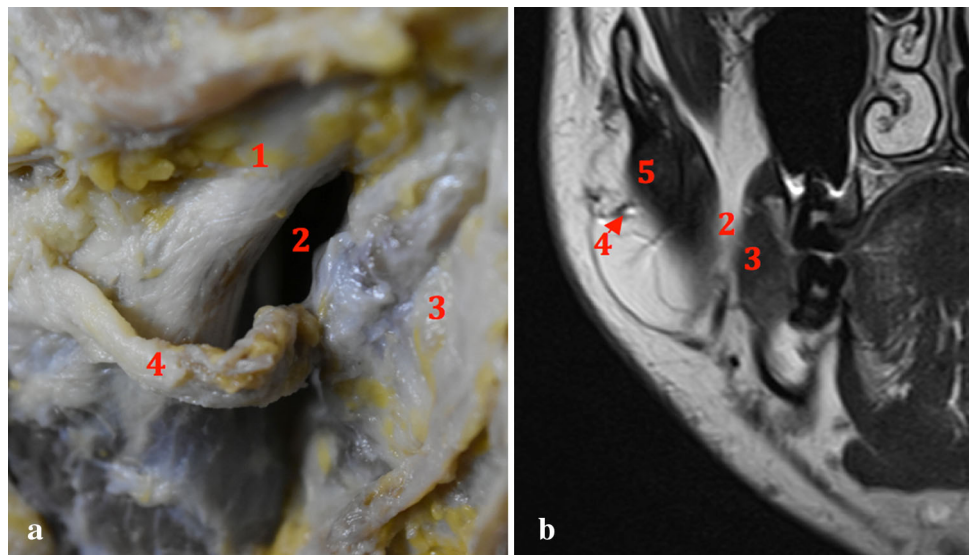
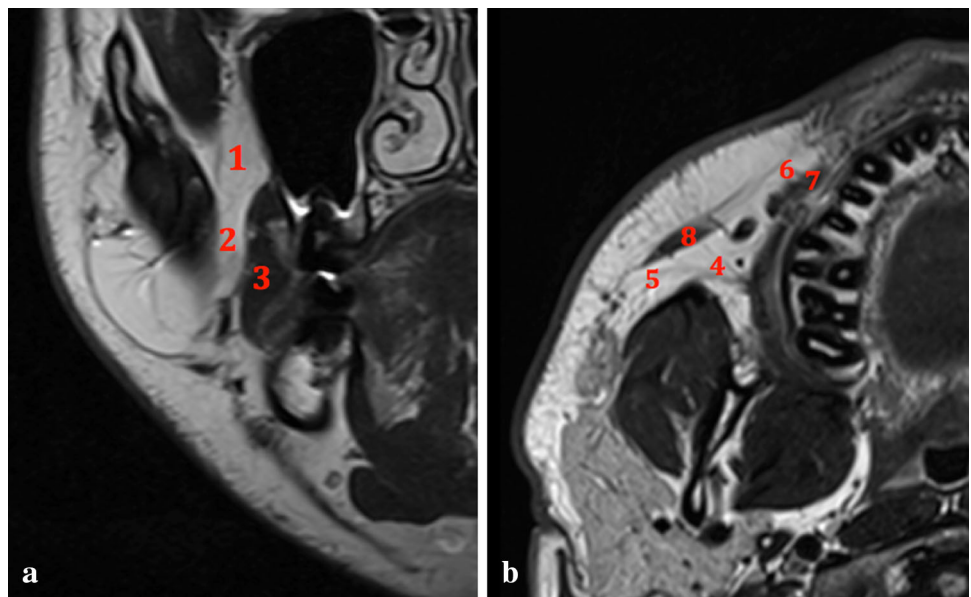


Fig. 5 a, b Cropped coronal (a) and axial (b) slices of T2-weighted MRI, showing the buccal extension of the MFP and its anterior prolongation. 1 Body of MFP, 2 buccal process of MFP, 3 buccinator muscle, 4 buccal fat pad, 5 posterior extension of buccal fat pad, 6 anterior extension of buccal fat pad, 7 levator anguli oris muscle, 8 zygomaticus major muscle



though Kostrubala [1] already described it as part of the MS in 1945. The key point for assuming that this anatomic region is a prolongation of a major space, instead of a space in itself, is to analyze its boundaries. In the present study, its boundaries were examined on 25 MRI scans, and the findings were complemented by dissection material from four heads of fresh adult human cadavers.

Some authors have pointed out that the BC does not have true superior and inferior limits [6, 11, 15, 18]. Conversely, in all cases examined in the present study, it was seen that there is an inferior limit given by a fascial sheet and the platysma muscle, because they attach to the mandible, and also by the depressor anguli oris muscle at the point where the platysma muscle converges with the depressor anguli oris. This is partially consistent with the statements made by Rodgers et al. [4], who said in 1988 that the inferior limit of the BC is formed as the fascia attaches to the periosteum of the mandible. Meanwhile, the superior boundary is given from posterior to anterior by the zygomatic bone, the zygomatic process of the maxilla, and the superficial layer of the masseter muscle at the point where it originates on the zygomatic process of the maxilla. Toward its most anterior section, the superior limit of the BC is given by the infraorbital margin of the maxilla and the corresponding muscles for facial expression originating at that level besides the subcutaneous and cutaneous tissues. Therefore, the canine fossa should be considered part of the BC.

In addition, despite the importance of the posterior boundary of the BC as a key to assuming that it is part of the MS, it is frequently described only briefly [17–20], indicating that its posterior limit is the anterior edge of the masseter muscle, the mandible, the lateral and medial pterygoid muscle, and the parotid gland. However, according to the present research, at the level of the thick tendinous aponeurosis of the superficial portion of the masseter muscle, a direct and free communication backward and upward from the BC to the infratemporal fossa was seen. This fact is very important because many authors have stated as a possibility for communication between the MS and the BC, only the area where the parotideomasseteric fascia is incomplete along its medial course or becomes thinner and is perforated by the projection of the buccal fat along its medial pathway to join the buccopharyngeal fascia [5, 6, 18, 20]. However, few authors have mentioned the fact that there is a direct communication between the BC and the infratemporal fossa medially to the tendon of the superficial portion of the masseter muscle, under its origin (on the zygomatic process of the maxilla, the zygomatic bone, and the zygomatic process of the temporal bone) as seen in the present study. In 1945, Kostrubala [1] stated that a portion of the buccal fat pad becomes continuous with the adipose tissue of the

infratemporal space. In 2007, Wei et al. [7] pointed out that the buccal fat pad provides a communication with the MS, while in 2014, Guidera et al. [12] indicated that the BC has continuity with the MS. In the present study, in the available dissection material, it was possible to easily remove the adipose tissue from the infratemporal space to the BC through the open path medially to the tendon of the superficial masseter muscle.

Another important issue to understand the BC as part of the MS is the MFP. This is because, despite the substantial available data on the deep facial fat, some authors still declare that temporal, pterygopalatine, and pterygoid fat, or some of it, is derived from the buccal fat pad [21], while others state that the buccal fat pad prolongs posteriorly and frequently communicates with the MS fat [6, 11, 22, 23]. In 1957, Gaughran [24] already stated that the buccal fat pad is one of the four main extensions of the MFP. In fact, the MFP is formed by a body and four extensions, and one of them constitutes the buccal fat pad. The anterior part of the MFP body gives the buccal fat pad, which has been imaged and described by several authors. In the present study, it was seen that a process from the MFP body reaches the BC, passing through a narrow passage formed posteriorly by the ending part of the tendinous aponeurosis of the superficial portion of the masseter muscle laterally and anteriorly by the medial wall of the BC. As described by Zhang et al. [22] in 2002, the present study visualized the buccal fat pad extending to the canine fossa, deep to the muscles that elevate the upper lip and superficially to the levator anguli oris.

Another important issue to clarify is the lateral and anterior limits of the BC. According to the results of the present study, the BC has an anterolateral limit, rather than lateral and anterior limits, as most of the facial expression muscles that constitute part of the lateral limit, which originate in the jaws and zygomatic bone, course antero-medially to converge into the orbicularis oris muscle, giving the BC a kind of arrowhead shape, with its point being the most anterior and medial part of the compartment, and lacking an anterior limit as such, in the way that has been stated [5].

Conclusion

In the present study, it was possible to detail the boundaries of the BC and verify statements made about this structure decades ago. This area should be assumed most precisely to be part of the MS, rather than a space in itself. This is mainly because there is a corridor positioned medially to the tendon of the masseter muscle that communicates the infratemporal region of the MS with the BC and through which the buccal extension of the MFP passes, with no

fascial barrier at this level that could separate the MS from the BC, thus permitting the spread of pathology both to and from the BC. Consequently, the fact that the BC is an incompletely enclosed space, because the parotideomasseteric fascia is sometimes incomplete along its medial course where it joins the buccopharyngeal fascia, appears negligible.

In addition, through the present work, it was shown that the BC encompasses a more extensive facial area than previously thought. Cranially and anteriorly, it includes the canine fossa, and caudally, it comprises the most inferior part of the mandible.

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Compliance with ethical standards

Conflict of interest Jorge Pinares Toledo, Roberto Marileo Zagal, Loreto Bruce Castillo, and Rodrigo Villanueva Conejeros declare that they have no conflict of interest.

Human rights statements All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.

Informed consent Informed consent was obtained from all patients for being included in the study.

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