Surgical and Radiologic Anatomy (2019) 41:809–813
https://doi.org/10.1007/s00276-019-02230-x

ORIGINAL ARTICLE

The parapharyngeal adipose corpus: anatomic and radiologic study

Pauline Nicol[1,2] · Jean-Marc Constans[3] · Marie-Pia d'Ortho[4] · Patrick Goudot[5] · Christian Vacher[1,2]

Received: 8 December 2018 / Accepted: 26 March 2019 / Published online: 3 April 2019

Abstract

Purpose Although the morphology of the parapharyngeal adipose corpus (PAC) has been already described, the clinical interest of its volume and weight in the genesis of obstructive sleep apnea syndrome (OSAS) is still controversial. The volume of the PAC has been determined in OSAS patients but not in a normal population. The aim of our study was to investigate the morphology of the PAC by dissection and MRI in a normal population and to determine if there is a relation between the dimensions and volume of the PAC and the Body Mass Index (BMI).

Methods Thirty hemifaces of 15 fresh cadavers have been dissected after silicone injection with dissection of the external carotid artery and its main branches, with harvesting of the PAC. The PAC has been measured and weighed. Twenty-nine MRI of healthy subjects have been examined to determine the volume of the PAC, the palate–pharynx distance, and epiglottis–pharynx distance.

Results In dissection study the weight of the PAC was 18.57 g ± 2.24, the vertical dimension (height) was 4.61 cm ± 0.51, the frontal dimension (width) was 1.62 cm ± 0.24. The blood supply of the PAC constituted of branches coming from the ascending palatal and ascending pharyngeal arteries. The volume of the PAC on the right side was 1.56 cm^3 ± 0.38, on the left side 1.54 cm^3 ± 0.37. Its horizontal greater dimension was 1.70 cm ± 0.07.

Conclusions There is a correlation between the volume of the PAC and the BMI in a normal population. A surgical resection of the PAC in OSAS patients by transoral robotic-assisted surgery can be proposed with preservation of the ascending palatal and ascending pharyngeal arteries.

Keywords Parapharyngeal adipose corpus · Obstructive sleep apnea syndrome · Body mass index · Magnetic resonance imaging · Dissection

Introduction

The anatomy of the parapharyngeal adipose corpus (PAC) has been described for the first time by Wolfram-Gabel et al. [16] in 1996. This adipose corpus is in continuity with the upper part of the buccal fat pad and is also a gliding structure [6]. In imaging it has been considered as an early marker of invasive tumoral process [5]. Some authors [8] consider that the volume of the PAC may contribute to the collapsibility of retropalatal and retroglossal airway, and may increase the risk of obstructive sleep apnea syndrome (OSAS). Although the morphology of the PAC has been already described [1, 6, 16], the clinical interest of its volume and weight in the genesis of the OSAS is still controversial. A correlation has been established between Body Mass Index (BMI) and OSAS [17], some authors demonstrated that the volume of fat deposition in the oropharynx is correlated to OSAS in obese patients [3, 9, 12], others consider that muscle

✉ Christian Vacher
christian.vacher@aphp.fr

1 Anatomy, University Paris Diderot, 75010 Paris, France

2 Department of Maxillofacial Surgery, Hôpital Beaujon, APHP, 100 boulevard du Général Leclerc, 92110 Clichy, France

3 Radiology, University of Amiens and CHU Amiens, Amiens, France

4 Sleep Medecine, Physiology, Functional Exploration Department, University Paris Diderot, Hôpital Bichat, APHP, Paris, France

5 Department of Maxillofacial Surgery, Sorbonne University, Hôpital Pitié-Salpétrière, APHP, Paris, France

hypertrophy or enlargement of non-adipose soft tissues could be correlated to OSAS [10, 13]. The aim of our study was (1) to investigate the dimensions, the volume and the blood supply of the PAC by a dissection study to determine if a safe mini-invasive surgical resection of the PAC would be possible (2) to evaluate the MRI morphology of the PAC in a population of patients without any OSAS to determine if there is a relation between the dimensions and volume of the PAC and the Body Mass Index (BMI).

Materials and methods

Dissection study

Thirty hemifaces of 15 fresh cadavers have been dissected (sex ratio: 9 women versus 6 men; middle age: 77, 68 [55–89] after silicone injection with the same technique). The cadaver was in supine position. An incision was performed on the anterior border of the sternocleidomastoid muscle. The carotid region was dissected and the common carotid was ligated. The internal jugular vein was ligated below the thyro-linguo-facial trunk. After washing the vessels with a saline solution, a 40 cc silicone preparation injection (20 cc fluid silicone addition 12 Sh 1/1 prevent transformation with 20 cc of catalyst and red or blue coloring agent) was injected on each side. After 48 h the dissection of the PAC was performed in all cases with the same technique. The external carotid artery and its main proximal branches were dissected. To improve the visibility of the PAC a section of the mandibular symphysis has been performed. In all cases, the styloid process was identified and the PAC was dissected to investigate its blood supply. The PAC was then harvested after identifications of the arteries giving its blood supply (Fig. 1). The PAC weight was measured using a Sartorius quintix balance and its maximal vertical and lateral dimensions were measured using a millimeter ruler.

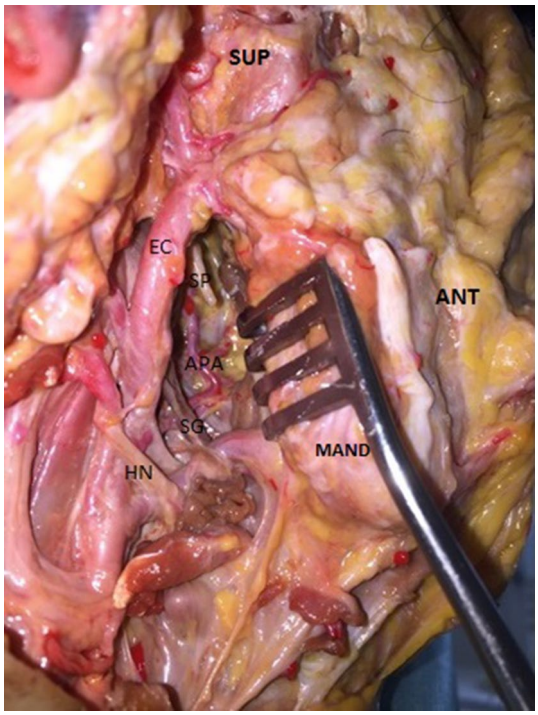

Fig. 1 Dissection cadaveric right view of the face after resection of the parapharyngeal adipose corpus (PAC). The mandibule (MAND) has been pulled forward to give access to the PAC area The external carotid artery (EC) gives a main branch that crosses the styloglossus muscle (SG) to vascularize the PAC: the ascending pharyngeal artery (APA). The styloid process (SP) is the posterior and superior landmark of the parapharyngeal space. The hypoglossal nerve (HN) is running to the submandibular area which is the inferior limit of the PAC area. *SUP* superior, *ANT* anterior

MRI study

Twenty-nine healthy volunteers had a MRI (3 T Achieva MRI scanner 16 channel neurovascular coil: Philips Corporation, Andover MA). The volunteers were all in good health, had neither OSAS, nor snoring and gave their written consent to the protocol; they did not present any contraindication to MRI. Clinical data concerning the patients have been collected (age, sex, size, weight). The sex ratio was 21 women/7 men and the mean age was 27.7 years. This protocol has been approved by Ethical Committee (CPP2 DIRRC Nord Ouest).

The sequences were determined in advance (T1, T2, T2 fat sat) with no injection, they were 40 min long. The slice thickness was 4mm and the interslice gap: 1 mm.

The acquisition method was:

- Sagittal T1 (at least 3 slices)
- Coronal T1 (at least 6 slices)
- Sagittal T2 (at least 6 slices)
- Coronal T2 and T2 Fat Sat (at least 6 slices).

The muscular functional acquisitions have been performed from the cricoid cartilage to the hard palate using a spin echo sequence. The time of repetition (TR) was 2500 ms and time of echo (TE) from 17.8 to 80 ms in T2-weighted sequences. TR was 400 ms and TE 8 ms in T1-weighted sequences. The muscular segmentation has been performed using the Philips Intelli Space software by the same investigator. The segmentation of the genioglossus muscle was manual, for the PAC it was semi-automatic (Fig. 2). The regions of interest (ROI) measures were given by the software (distance between the posterior border of the soft palate and the posterior wall of the pharynx on a horizontal plane, and distance between the epiglottis and the posterior wall of the pharynx on a horizontal plane).

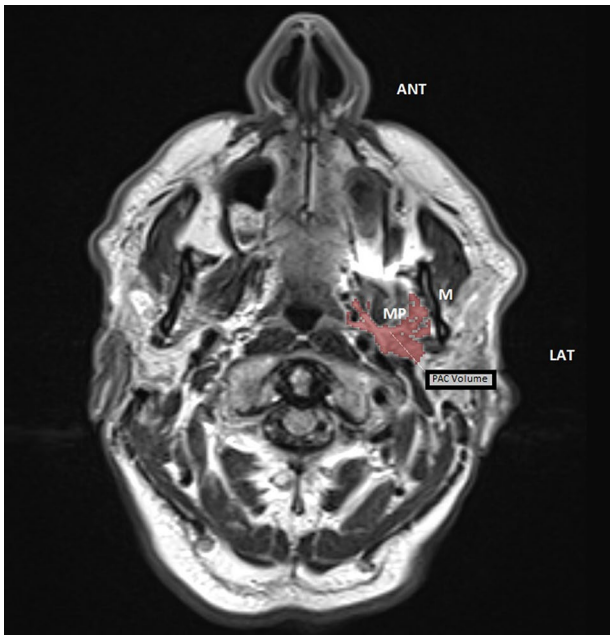

Fig. 2 MRI axial section showing semi-automatic segmentation. The software recognizes the gray levels corresponding to the parapharyngeal adipose corpus (PAC) and calculates the volume of the region of interest. The PAC is in contact with the mandible (M) laterally and with the medial pterygoid muscle medially and ventrally (MP). *ANT* anterior, *LAT* lateral

Statistical analysis

Pearson' s correlation analysis was used to investigate the relationship between the BMI and (1) the volume of the PAC determined for each healthy volunteer calculating the mean value of the both sides (2) palate–pharynx distance (3) epiglottis–pharynx distance. A p value of <0.05 was considered statistically significant for the correlation.

Results

Dissection study (Table 1)

The limits of the parapharyngeal space where the PAC was located were: (1) the medial pterygoid muscle anteriorly and laterally (2) the styloid process with the muscular insertions of the styloglossus and stylopharyngeus muscles posteriorly and laterally (3) the superior constrictor of the pharynx medially (4) the cranial base cranially. The inferior limit was more difficult to determine because of communications of the parapharyngeal space with the submandibular area adipose tissue. It has been considered that the inferior limit was the horizontal part of the lingual nerve. The blood supply of the PAC was symmetric in all cases and was made of two arteries: (1) the ascending palatal artery which was a branch of the facial artery in 13/15 cases (86.7%), and a direct branch of the external carotid artery in two cases (3.3%) and (2) the ascending pharyngeal artery which was a direct branch of the external carotid artery in all cases (Fig. 3). The weight of the PAC was 18.57 g ± 2.24, the vertical dimension (height) was 4.61 cm ± 0.51, the frontal dimension (width) was 1.62 cm ± 0.24.

Table 1 Mean values of the measures the PAC performed on 30 dissections of 15 fresh cadavers

Dissections	Age	Length (cm)	Width (cm)	Weight (g)
30s	77.68	4.61	1.62	18.57

MRI study (Table 2)

The Body Mass Index (BMI) of the population was 22.13 ± 3.25 (18.7–31.6), the median weight of the patients was 64.03 kg ± 11.26. The volume of the PAC on the right side was 1.56 cm^3 ± 0.38, on the left side 1.54 cm^3 ± 0.37. Its horizontal greater dimension was 1.70 cm ± 0.07.

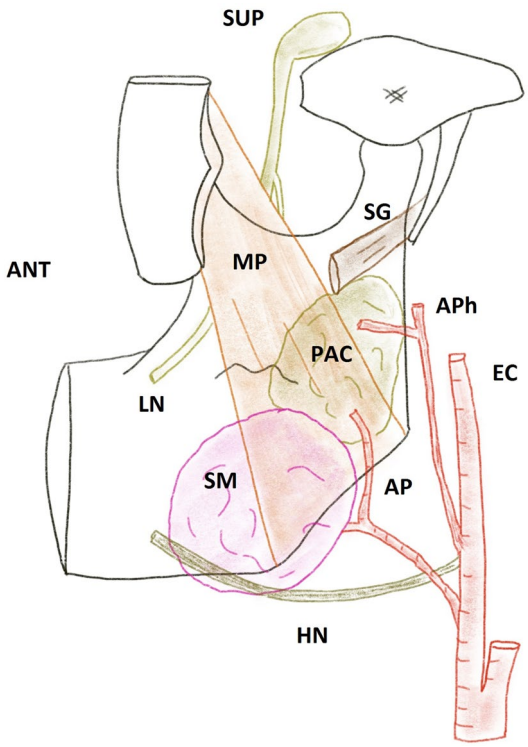

Fig. 3 Medial view of the parapharyngeal adipose corpus (PAC) area. The limits of the PAC area are constituted by the styloglossus (SG) muscle cranially and medial pterygoid muscle (MP) medially. On the lower side it is in close contact with the submandibular gland (SM). The lingual nerve (LN) is crossing the submandibular area cranially, and the hypoglossal nerve (HN) caudally. The blood supply of the PAC is provided by both ascending pharyngeal artery (APh) and ascending palatal artery (AP) which are branches from external carotid artery (EC). *SUP* superior, *ANT* anterior

Table 2 Mean values of the BMI, volume of the CAP on right and left sides, horizontal distance between the posterior border of the soft palate and the posterior wall of the pharynx, and horizontal distance between the epiglottis and the posterior wall of the pharynx

Patients	Age	BMI	Right CAP volume (cm^3)	Left CAP volume (cm^3)	Palate–pharynx distance (mm)	Epiglottis–pharynx distance (mm)
29	27.7	22.13	1.56	1.54	643.31	584.9

The horizontal distance between the posterior border of the soft palate and the posterior wall of the pharynx was 643.31 mm ± 236.17 and the horizontal distance between the epiglottis and the posterior wall of the pharynx was 584.9 mm ± 168.62. The BMI and the PAC volume were related (correlation coefficient: 0.505 and p value < 0.01) Fig. 4). The BMI was not related to the distance soft palate-pharynx (correlation coefficient: − 0.204 and p value > 0.10); it was not related to the epiglottis–pharynx distance (correlation coefficient: − 0.014 and p value > 0.10) (.

Discussion

In this study, the dissection allowed a description of the size and weight of the PAC and the MRI on 29 patients with no OSAS, we found a statistical correlation between the volume of the PAC and the BMI, although there were no correlation between the BMI and the horizontal distance between the posterior border of the soft palate and the posterior wall of the pharynx and the BMI and the posterior wall of the pharynx. This study has been performed on a normal population to precise the normal anatomy and volume of the PAC as a possible site of fat tissue deposit correlated to the BMI, it will be completed by a further study of the PAC in OSAS population. Our dissections confirm the limits of the PAC already described by Wolfram-Gabel et al. by a radiologic (CT scanner and MRI) and histologic study and Colin et al. by a dissection and MRI study [1, 16]. The size of the PAC in our dissections (height: 4.6 cm, maximal width: 1.6 cm) was very close to the description of Colin et al. (length: 4.8 cm, median width: 1.2 cm) [1]. No radiologic study has been performed in our knowledge about the volume of the PAC in a normal population and BMI correlation. Many studies have been performed about fat accumulation in the tongue [2, 7]. Godoy et al. demonstrated on a CT scanner study that tongue fat accumulation parallels whole-body adiposity and there is a correlation between increased tongue fat content and abnormal upper airway measures [2]. Kim et al. performed a MRI study in overweight or obese apneics and non-apneics which showed that the amount of tongue fat in obese apneics was greater than in obese controls [7]. Other studies investigated the correlation between parapharyngeal fat pad and OSAS. Pahkala et al. [11] compared two groups of patients (OSAS group and overweight habitual snorers with no OSAS group). The BMI difference was not significant between the two groups. This study demonstrated that the volume of the PAC was larger in OSAS than in habitual snorers. Li et al. compared two groups with the same BMI in a MRI study: one group with OSAS, and another one of healthy patients. The volumes of fat in soft palate and parapharyngeal fat pad in retropalatal and retroglossal region were significant predictors of OSAS [8]. The correlation between BMI and volume of PAC has been studied by some authors mainly on obese patients with OSAS. Sutherland et al. demonstrated that weight loss was associated with a reduction of parapharyngeal fat volume [14]. This last study and the correlation we found between BMI and PAC volume lead us to propose slimming to OSAS patients with high PAC volume. Jang et al. studied a population of 33 adult patients with OSAS. They measured the volumes of the PAC and the retropalatal airway and the retroglossal airway that we evaluated by the horizontal distance between the posterior border of the soft palate and the posterior wall of the pharynx and the horizontal distance between the epiglottis and the posterior wall of the pharynx. The mean volume of the PAC was 4.81 cm^3 in OSAS patients, more than twice than in our normal population. They found that the volume of PCA was statistically associated with age and BMI, but not apnea–hypopnea index, retropalatal airway volume or retroglossal airway. According to Jang et al., the PAC seems to affect the collapsibility of the retropalatal pharynx [4]. Our study confirms that the relation between BMI and volume of the PAC, already demonstrated in OSAS patients is also in a normal population. PAC excessive volume could explain bad results of tonsillectomy in OSAS treatment, because the pharyngeal transverse diameter stays too much small after surgery. Considering the relation existing

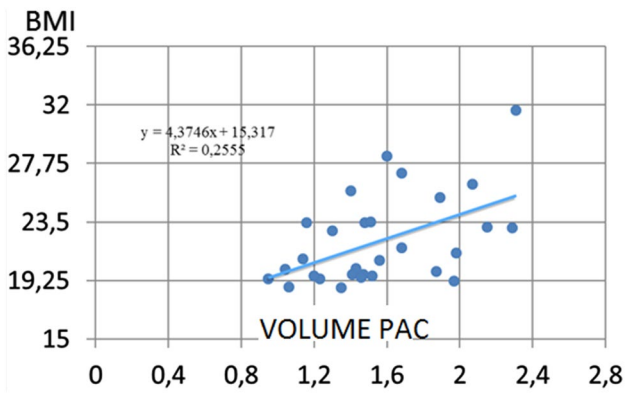

Fig. 4 Scatter plot of volume of the parapharyngeal adipose corpus (PAC) and Body Mass Index (BMI). A statistically significant positive correlation exists between PAC volume and BMI

between volume of the PAC and OSAS, it is important to consider that in our study the volume of the PAC was inferior to 2 cm^3 in a normal population. In case of OSAS with volume of the PAC increased, we suggest that a surgical resection of the PAC could be proposed by transoral robotic-assisted surgery. This technique, usually used in surgery of small carcinomas of the pharynx [15], could be investigated in OSAS patients because of the difficult surgical access of the PAC and to limit the morbidity of the surgery in overweight patients. Although the anatomical limits of the PAC have already been described [1, 16], the vessels passing across this region are important to identify to limit the risk of operative and postoperative bleeding which can be important in this procedure in a area contaminated with saliva. The blood supply of the PAC depends on the palatine ascending artery [1] and also by the ascending pharyngeal artery on its upper part. The vessels have to be preserved if a resection of the PAC is performed.

Author contributions PN: protocol development, data collection, data analysis, and manuscript writing. JMC: protocol development, data collection and manuscript writing. MPO: protocol development and data collection, PG: protocol development, CV: protocol development, manuscript writing and editing.

Funding None.

Compliance with ethical standards

Conflict of interest We have no conflict of interest to declare.

References

1. Colin V, Gavid M, Timochenko A, Prades JM (2017) Le corps adipeux parapharyngé: anatomie chirurgicale et imagerie. Morphologie 101:71–76
2. Godoy IRB, Martinez-Salazar EL, Eajazi A, Genta PR, Bredella MA, Torriani M (2016) Fat accumulation in the tongue is associated with male gender, abnormal upper airway patency and whole-body adiposity. Metabolism 65:1657–1663
3. Horner RL, Mohiaddin DG, Lowell SA (1989) Sites and sizes of fat deposits around the pharynx in obese patients with obstructive sleep apnoea and weight matched controls. Eur Respir J 2:613–632
4. Jang MS, Kim HY, Dhong HJ, Chung SK, Hong SD, Cho HJ, Jung TY (2014) Effect of parapharyngeal fat on dynamic obstruction of the upper airway in patients with obstructive sleep apnea. Am J Respir Crit Care Med 190:1318–1321
5. Kahn JL, Bourjat P (1996) La région péripharyngée: anatomie et imagerie normale. J Radiol 77:87–97
6. Kahn JL, Sick H, Laude M, Koritke JG (1987) La boule de Bichat ou corpus adiposum buccae. Arch Anat Histol Embryol Norm Exp 70:33–71
7. Kim AM, Keenan BT, Jackson N, Chan EL, Staley B, Poptani H et al (2014) Tongue fat and its relationship to obstructive sleep apnea. Sleep 37:1639–1648
8. Li Y, Lin N, Ye J, Chang Q, Han D, Sperry A (2012) Upper airway fat tissue distribution in subjects with obstructive sleep apnea and its effect on retropalatal mechanical loads. Respir Care 57:1098–1105
9. Mortimore I, Marshall J, Wraith PKP, Sellar R, Douglas N (1998) Neck and total body fat deposition in non-obese and obese patients with sleep apnea compared with that in control subjects. Am J Respir Crit Care Med 157:280–283
10. Ozturk E, Dalayman D, Sonmez G, Mutlu H, Sildiroglu HO, Basekim CC, Kizilkaya E (2007) The effect of pharyngeal soft tissue components on snoring. Clin Imaging 31:259–263
11. Pahkala R, Seppä J, Ikonen A, Smirnov G, Tuomilehto H (2014) The impact of pharyngeal fat tissue on the pathogenesis of obstructive sleep apnea. Sleep Breath 18:275–282
12. Shelton KE, Woodson H, Spencer G, Suratt PM (1993) Pharyngeal fat in obstructive sleep apnea. Am Rev Respir Dis 148:462–466
13. Schwab RJ, Gupta KB, Gefter WB, Hoffman EA, Pack AI (1995) Upper airway soft tissue anatomy in normal and patients with sleep-disordered breathing: significance of the lateral pharyngeal walls. Am Respir Crit Care Med 152:1673–1689
14. Sutherland K, Lee RWW, Philips CL, Dungan G, Yee BJ, Magnussen JS, Grunstein RR, Cistulli PA (2011) Effect of weight loss on upper airway size and facial fat in men with obstructive sleep apnoea. Thorax 66:797–803
15. White HN, Moore EJ, Rosenthal EL, Carrol WR, Olsen KD, Desmond RA et al (2010) Transoral robotic-assisted surgery for head and neck squamous cell carcinoma: 1- and 2-year survival analysis. Arch Otolaryngol Neck Surg 136:1248
16. Wolfram-Gabel R, Kahn JL, Bourjat P (1997) The parapharyngeal adipose corpus: morphologic study. Surg Radiol Anat 19:249–255
17. Young T, Peppard PE, Taheri S (2005) Excess weight and sleep-disordered breathing. J Appl Physiol 99:1592–1599