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Case report

DISTAL LOWER MOLAR REGION, RETROMOLAR REGION AND RETROMOLAR CANAL: ANATOMICAL AND SURGICAL IMPLICATIONS.

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ABSTRACT

The mandibular retro-dental trigone, a region laying right behind the third or second lower molar, is a rather small anatomical area, where genetic-driven and epigenetic events do actually combine to determine skull and mandibular development in a wide number of mammal species. Here we describe some areas, comprised in the retro dental region, that clearly appeared to us as being separate from one another, yet also partially overlapping. We suggest that the "DALM" (distal area of lower molar) term should be preferred as referring to an area that would include both the retromandibular fossa and the mandibular retro dental (or retromolar) trigone (RMT). We justify this choice given the number of anatomical variants described in literature involving bony parts as well as vascular and nervous structures in this area. RMT, with its "retromolar pad", is strongly involved in oral mucosa pathologies as precancerous diseases, neoplasms, and molar inclusion-related abscesses.

1. Introduction

The oral cavity with occluded dental arches shows an apparent separation between the vestibule and the interior of the actual oral cavity. In fact there is a virtual communication through a very small space at the end of the dental joint, the so-called Zuckerkandl' retro-molar/dental space,[1-3] which can only be inspected by digital palpation crossing the oral vestibule in an antero-posterior direction, reaching beyond the last molar[4]. Describing this region, we will refer to the anterior, posterior and axial orthogonal planes for the topographical localization of the structures of interest.

The terms "mesial" and "distal" are used in dentistry in relation to the walls of the teeth with respect to the midline, whereas the "proximal" and "distal" terms serve to indicate, respectively, the more or less proximity of the anatomic structure to the incisal midline.

The posterior mandible is in the terminal part of the mandibular body distal to the mental foramen ; while the anterior mandible is located between the two mental foramina [5].

Based on studies about both phylogenesis and ontogenesis, one may affirm that the area right between the junction of mandibular body with each of its branches (area of the retromolar/dental space: RMS/DS) has gone through significant variation during the evolution of the human species; it is commonly considered a Neanderthal autapomorphy[6].

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The paleoanthropologists[6,7] define RMS as the space of separation posterior to the mandibular third molar, placed between the distal margin of the third molars and the anterior margin of the ramus.

They[7] believe that facial prognathism with the creation of an RMS of variable size is not an anthropomorphically trait exclusive of the Neanderthals, since it is found in the protohistoric Amerindians and also in anatomical modern humans. The morphology of the RMS appears to be the final result of numerous cranial traits and its developmental characteristics are related to hereditary and post-natal development affected by the adaptation to heavy loading due to the action of masseter and temporalis muscles on the anterior dentition, anterior migration of the postcanine dentition and reduction in length of the dental arcade[7]. So, post-natal ontogeny, on the basis of genetic information and response to environmental factors, determines changes in the spatial relation between the ramus and the corpus in relation to the vertical growth of the face, also procuring changes in the RMS[6].

In the anatomy of the "modern humans", the small latero-lateral Zuckerkandl' retro-dental passage has dimensions of about 4 mm transversally and 6 mm in the sagittal direction so as to allow the passage of a surgical sonde of such dimensions[2]. Structurally it consists of the proximal portion of the mandibular body, constituting the base of the retro-dental area, until it reaches the point where it continues with the vertical branch of the mandible [4,8-10]. Laterally, the mucosa of the cheek lying on the free space, which represents the Zuckerdandl' aditus to the oral cavity, virtually occludes it. Medially, the rear margin of the root of the tongue closes the passage of this minimal canal arranged in the vestibular-lingual sense.

2. Lower retromolar area: anatomical implications

From a topographical point of view[2,5,11,12] a lower retromolar anatomical area is outlined; inside it two other "sub-areas" can be identified: the mandibular coronoid lateral bony crest ending downwards and forwards to a small particular elongated depression, deep enough to be regarded to as "fossa" in the retromandibular site[10]. A medial bony triangle is located just distal to the last molar, frequently that of the wisdom tooth, and its medial boundary is the lateral lip of the "fossa" [5]. These two areas actually define this region, while distally and laterally, the mucosa covers a third area consisting of the fold of the pterygomandibular ligament[3,10,12]. This area is also referred to as the anesthetic area since it can be used for the inferior alveolar nerve block (IANB) [3,5]. Thus a lower retromolar anatomical area is outlined, within which two further "sub-areas" can be identified: one resting immediately behind a last lower molar (the so called retromolar space or triangle: RMS, RMT) [4,5] and another one laying slightly more posterior and lateral to the previous, the aforementioned retromandibular "fossa"[10]. All this bony base is limited superiorly by the tuberosity of the upper jaw and by the third upper molar if present in the upper dental arch[3]. On the medial side it presents partly also the palatoglossus muscle, therefore relating with the adjacent tonsillar region[10] and finally with the medial pterygoid muscle. Nevertheless, it seems rather a "forced", scholastic distinction, because, as a matter of fact, the two small anatomical areas lay contiguously to one another, actually continuing in one another, reason for which the entire area comprising the two can be referred to as distal area of the lower molar, that we define: Distal Area of Lower Molar (DALM) (Figure 1) [11].

The mucosa that covers the DALM consists of non-keratinized stratified squamous epithelium with various degrees of parakeratinization[5,12-14]. RMT, whose dimensions are on average about 0.8/1 mm transversely and 1/2,5 mm in the sagittal direction[8], has clinical and pathological interest, due to the presence, in such region, of anatomical structures of potentially high pathological relevance [8,15,16]. The mucous tissue of RMT raises into a large gingival papilla antero-posteriorly elongated and covered by mucous tissue, the so-called "piriform papilla" or also "retromolar-pad"[3,10]. Here we can observe minor accessory salivary glands in the submucosa which are continuous with similar glands in the palatal mucosa[15,16]. This could allow the passage of infiltrates and abscesses between the two regions as well as for the tonsillar region [8,9,16]. Some sebaceous glands are quite evident as yellow isolated spots, the so-named "Fordyce's spots" [17,18].

The vestibular space of the buccinator muscle [3] is an anatomical compartment, internal with respect to the muscle, forming a concave plane open anteriorly, the so-called "latero-alveolar canal" [12], continuous with the retro-molar "fossa".

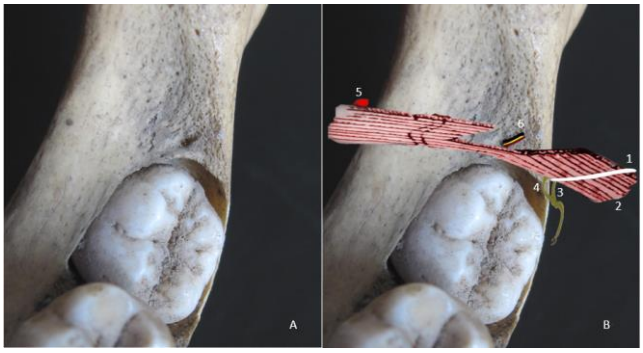

Figure 1. Human mandible, right side. Panel A: Distal Area of Lower Molar (DALM) of dry mandible with RMF about 4 mm away from the distal margin of the crown of the lower third molar impacted. Panel B: analytical reconstruction of the retromolar bundle and other anatomical components; the variant of the lingual nerve (30%) that enters the DALM is shown. With progressive arabic numbers we indicated the anatomical structures of interest: 1 = pterygomandibular ligament; 2 = muscle bucco-pharyngeal; 3 = lingual nerve; 4 = variation pathway of lingual nerve that goes in retromolar pad; 5 = external maxillary artery; 6 = retromolar bundle (vein, nerve, artery).

It could be a pathway through which purulent material can flow arising from pericoronitis of the lower third molar involving the RMT (migrating abscess of Chomprette-L'Hirondel) [2,19]. Such material can, therefore, reach the point where the muscle layers discontinue and then open, this leading to the formation of a cutaneous fistula at the level of the first or second premolar site, and basically very close to the mental foramen[8]. Most part of the vestibular buccinator space is filled with tissue adipose part of Bichat' buccal adipose pad [8,20,21]. On the skeletal plane, the retro-mandibular "fossa" may present one or more foramina[5,14] through which access can be gained to related accessories canals (the so-named retromolar accessory canals: RMC), which are in connection with the mandibular main canal (Figures 2 and 3). These foramina can also be found at RMT bone-base[8].

This bone base can display a cribriform appearance and structure, and its thickness is reported to usually be just slightly lower than 2 mm. Thus, it may allow easy anesthetic diffusion towards the inferior alveolar determining an anesthesia with effects similar to the inferior alveolar nerve block[2,9,12,13,20]. This, however, could also be facilitated by the presence of RMC which has nerve fibers in relation to the inferior alveolar nerve[13].

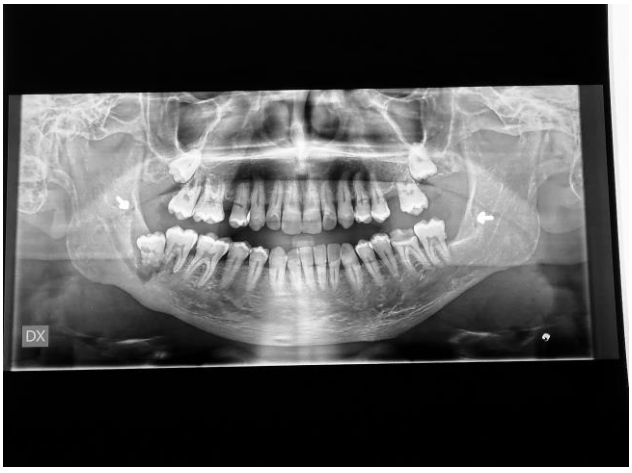

Figure 2. This figure shows Rx OPT images, in which you note a thin vertical shadow in DALM comparable to bilateral RMC (white arrowheads). The figure is original, it belongs to one of the authors (who has permission to publish) and has never been published before

Figure 3. This figure shows CT images related to the same clinical case reported in figure 2. The suspected RMC in OPT is clearly evident. The figure is original, it belongs to one of the authors (who has permission to publish) and has never been published before.

3. Retromolar trigone: clinical and surgical point of view

In the great majority of cases, RMT has been found to show a triangular shape[8]. For RMT the "drop-shaped" and the "tapering" type appearance is much less frequent[20].

This region is involved in a number of very important maxillo-facial procedures[22], as well as in implant surgery, and in orthognathic surgery involving sagittal split ramus osteotomy. Frequently, dental procedures such as the surgical removal of the lower wisdom tooth and other impacted teeth and sometimes operculectomy[23,24] also deal with anatomical structures of RMT. Furthermore, the same area can also serve as a donor site for autologous bone grafts [5,8,12].

The insertion of the anterior tendon of the temporal muscle[10] continues towards the bottom of the retromolar triangle, posterior to the mandibular third molar and finds attachment with its medial fibers to the medial edge of the retromolar triangle. The lateral fibers reach the mandible almost up to the RMT and sometimes delimit it[9].

Therefore, it can, be said that RMT locates behind the last lower molar tooth, with the last upper molar representing the tip of such triangular shaped area (facing backwards), sort of pointing at the maxillary tuberosity. The two aforementioned bone crests continue respectively with the free alveolar bone portion, lingual and buccal, of the lower third molar[25]. According to some authors[5,12], the region would also incorporate the third lower molar, although this cannot apply to cases in which impacted third lower molar is horizontally positioned. In the case it is fully normally erupted or partially erupted, such tooth should be considered as the anterior limit of RMT[5,8].

Furthermore, it can be said that the extension of the region is actually variable[8,9].In fact it will be wider when the third lower molar is not present or horizontally displaced (in this last case taking part to the floor of the region). Two are the conditions that can normally occur when the aforementioned tooth is not present. In the case of agenesis or loss of the third molar, the posterior face of the second molar would form the anterior wall of RMT.

In the case of the removal of the third molar and/or cyst of the posterior mandible, the scar tissue becomes part of the region and the fossa may appear a little more depressed due to alveolar bone resorption [23,24,26].

The retromolar mucosa continues laterally with the buccal mucosa and medially with the anterior arch of the tonsillar cavity, and can become edematous due to inflammatory diseases that arise in those regions. Even tumors could arise, especially from the tonsil and invade the RMT[9].

The mucosa that continues posteriorly covers a structure that is a fibrous band extending from the anterior edge of the main mandibular foramen of the vertical mandibular branch to the hook of the pterygoid hamulus and the medial pterygoid plate, thus constituting the pterygomandibular ligament, which reaches the posterior limit of the mylohyoid line on the internal face of the mandibular body. Such line becomes a union knot for the origin area for the fibers of the buccinator muscle[3] as well as for those belonging to the superior pharyngeal constrictor muscle [2,27,28].

The first of these fibers extends from the lateral maxillary crest to the lateral mandible bone surface, while posteriorly it inserts its own fibers to the pterygomandibular ligament.

Postero-laterally, masseter muscle fibers can be seen as well.

According to literature, the pterygomandibular ligament can be considered as a "modiolus" serving for the attachment of some muscle fibers of all these muscular structures. This ligamentous area, together with the retromolar fossa, is used by dental prosthetists as a posterior sealing line for the lower denture in the sense that if overextended, its tension causes the movement of the lower dental prosthesis[11]. For this particular position, the entire RMT can be considered an anatomical crossroad where muscle and nerve components converge. The external maxillary artery can be found between the pterygomandibular space and the interpterigoid fascia covering the lateral pterygoid muscle[2,3,27.] Such data have to be taken into account when this area is approached for dental and/or maxillofacial surgery, especially if mandibular sagittal osteotomy is necessary, but also in every case involving oral surgery at the RMT site.

Posteriorly, the buccinator space is separated by a fascial plane from the masticatory space and its adipose content[28].

The pterygomandibular space, which is located between the mandible and the pterygoid muscles, is posterior to the RMT. Furthermore, the buccal space can communicate directly with the entire masticatory space, due to the fact that the parotid-masseteric fascia is often incomplete at its medial side, where it joins the buccopharyngeal fascia[8]. The temporal muscle with its fibers and tendons forms an important part of the anatomical structures delimiting this small region. Its deeper fibers attach to the upper two-thirds of the medial limit of the retromolar fossa, while the superficial ones attach to the upper third of its lateral limit and can reach also the alveolar lateral crest of third molar[10,13].

The temporal muscle[2,3] is of clinical importance as it is a reference point for the manual reduction of the anterior dislocation of the temporomandibular joint and can be a landmark for the troncular dental anesthesia of the IANB[9]. Moreover, it constitutes one of the posterior limits of the mobile dental prosthetic artifacts[10,11].

All of these boundary and support structures present vessels and nerves, that can either run alongside the walls or inside them.

The median portion of the medial wall of the RMT is crossed by both the buccal artery, the last branch of the bundle of the muscular portion of the internal maxillary artery, and by the buccal nerve, which is responsible for the sensitivity mainly of the mandibular vestibular mucosa and of the gingiva. Vestibular addition buccal nerve anesthesia is part of the anesthetic technique during surgery of the posterior mandibular region to desensitize the vestibular mucosa[4, 8].

The lingual nerve runs in the gingival mucoperiosteum along the lower part of RMT medial wall, very closely to the lower edge of the superior pharyngeal constrictor muscle[15] and it is adjacent to the medial surface of the cervical margin of the lower third molar. In less than 20% of cases, it rises up to the alveolar ridge of these teeth[14]. Therefore, it is often involved during surgical procedures for the removal of this molar and postoperative sequelae may occur involving paresthesia/anesthesia of the relative half of the tongue. This phenomenon could be avoided by preparing the lingual mucosal side, detaching it completely to full thickness and then, protecting it with a flat surgical retractor[29,30]. It has been reported also that lingual nerve may appear deviated from its most usual path. A few millimeters lateral deviation may occur[31] leading to the access for such nerve to the RMT, in particular in the adipose tissue pad present here[13].

From an anatomical point of view, in such a case the whole structures involved together form a kind of triangular-shaped area raising above the mucous plane, where the mucosa actually covers the adipose matter with some bundles of the muscles[4] that cross here. This natural swelling is named retromolar pad-gland/piriform papilla[10].

Here, local anesthetic infiltration might be used, even in the absence of the RMC, because it reaches the "bone cancellous base" which has a small thickness of less than 2 mm[5,12,20].

4. Distal area of the lower molar: pathological and surgical point of view

DALM clearly is a region of anatomical interest[11,13,21] involved in surgical interventions (Figure 4). It is also important due to its content, which is not limited to the mucosa and submucosal glands, but also including small anatomical structures of great importance both pathologically and surgically. The lower alveolar bundle, directed to its own mandibular canal, runs in the mandibular body from the incisal site and mental foramen to the mandibular foramen. It is normally composed of a large main trunk plus tinier satellite trunks running alongside the main one[2-4,32,33].

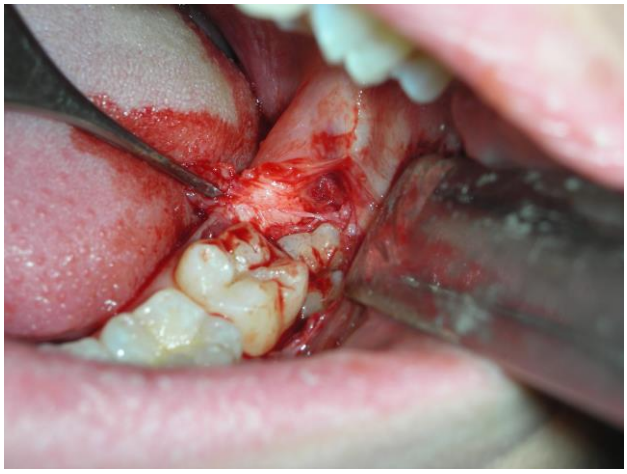

Figure 4. The figure shows an in vivo Distal Area of Lower Molar (DALM), in which we note the presence of impacted third molar and a thin retro dental bundle. The figure is original, it belongs to one of the authors (who has permission to publish) and has never been published before.

The nerve component is responsible for the somatosensory sensations of the teeth, of the interdental papilla with the periodontal tissue and of the alveolar bone.

It is known to be a unique structure but the existence of anatomical variations such as its duplicity and the presence of accessory canals in the DALM have been reported by numerous studies over time. The term used to define a double mandibular canal is bifid, while the canals in DALM are referred to as retromolar canals (RMC) and their access holes as retromolar foramina (RF) (Figure 5).

The researchers used these definitions by superimposing their meaning and not specifying the anatomical location. Consequently, some confusion has arisen in the anatomical terminology and on this point some clarifications are necessary. In fact, some accessory channels in DALM are as a short duplication of the main channel and are a real form of bifidity, while other channels in the same area have small dimensions and are not considered important variants of the main channel.

The mandibular canal can also appear with triplications (trifid canal)[33,34]. So, while some of tinier satellite trunks continue to follow the main trunk in its path, others can branch furtherly to give rise to collateral branches variously sized. Among those, one in particular may be thick and extended enough to impose the generation of a secondary, parallel mandibular canal. This is the condition anatomically renewed as “bifid mandibular canal”[34]. The position of the RMC in the small DALM area is reported by various researchers in the RMT or in the retromolar "fossa"[4,18,19]. The RMC, in fact, has just one denomination that indicates it in the retromolar seat. This could be explained by the possibility that the anatomical variants are not always constant for their appearance and also for the position.

Figure 5. The figure shows a Retromolar Foramen of noticeable diameter (white arrowhead).

What is certain is that throughout the DALM area, foramina are described with access to relative canals of various sizes and numbers[4] and that sometimes, and not always bilaterally, some are of large size so as to be a real problem during oral surgery. Some vascular- nervous canals in DALM, although inconstant in their anatomical presence, are more or less constant in their position, which could be based on genetic transmission[12,14]. However, the DALM is so small that it seems possible a change of position of a few millimeters so as to place an accessory channel of evident caliber in RMT or in retromolar "fossa" due to their proximity. So, accessory canals in the DALM site can also be one or more[34] and the diameters can be much smaller, typically less than 0.5 mm each[7].

This type of presentation is normally referred to as unfathomable channels and, therefore, are not considered remarkable[19]. Some channels, on the other hand, are large and very evident.

Here, the artery could not always be present[11], but can actually be the most evident structure, accompanied by numerous myelinated nerves, venules and fascicles, which are always located at the periphery of the bundle[10]. Nerve fibers originating from RMC[35] seem mainly distributed to the temporal tendon, the buccinator, the more posterior part of the alveolar process and the lower third molar. The microscopy investigation indicates that the most constant element in RMC is a myelinated nerve[12,14,22]. Therefore, in the RMC there are vessels and nerves whose vascular and nervous axis of origin is still under discussion, probably because often the vessels are anastomosed to each other and the course of the nerves can have variations which have different reports by various authors [2,12,14,35]. Thus, the vessels may originate from the alveolar artery or from the buccal artery, and its nerve bundles may be buccal or inferior alveolar or both. However, some studies[2,14] have suggested that RF and RMC would be normal anatomical variations of the IAN, rather than anomalies. If damaged, these vascular-nerve structures can cause annoying intraoperative bleeding and limited and localized postoperative paresthesia/anesthesia, which can cause bothersome sensations to the patient[5,13,23]. In most clinical cases, these anatomical conditions are ignored by dentists, also because they are infrequently described. Moreover, on the panoramic radiographs it is difficult to notice these accessory structures[36]. Instead, it is useful to know that CT 3D images of DALM skeletal[8,25,32,37] can more easily reveal the existence of such accessory canals.

Nevertheless, these accessory canals can also be identified on rx orthopantography[37-42]. Their occurrence is indicated about 30-35%[36], although another study showed an incidence for such condition equal to 70%[38]. When present, the retromolar canal is typically shown to cross the portion of the bone located above the main mandibular canal, with caudo-cranial direction, forming a postero-superior curve. Therefore, the RMF is found more posteriorly than the entrance foramen placed at a lower level above the alveolar canal.

Nevertheless, cases have been reported indicating a horizontal or tortuous path for such an accessory canal, also classified into three main types plus several subtypes[40-42.] Their presence is no longer considered anatomically an exception but a very frequent variant[42]. Among their variants, the curved path[41,42] is more frequently seen than the horizontal one and is normally placed in the center of the RMT. A vertically arranged retromolar canal has been also described. It usually lays more anteriorly, close to the third molar. The horizontal retromolar canal is the rarest type found. It arises distally to the third molar and is the highest of the three, almost reaching the "Spix spine” level[8]. The RMC would form due to the incomplete fusion of single mandibular canals that are present in the mandible of the human fetus[43].

To note, CBCT studies report large variability of incidence, for frequency, location, diameter, and extension of RMC[18,40]. Regarding the age, the occurrence rate has been studied in adolescents and the higher range may be associated to the growth-related need with possible reduction or disappearance in relation to the development of the wisdom tooth[41]. This variability is also reported to be related to environmental, genetic and ethnic factors[14]. Lymphatic drainage of the region is directed towards the deep superior jugular lymph nodes with cases of drainage towards peri-parotid and retropharyngeal stations[44].

Vascularization of the retromolar area is mainly provided by the collateral branches of the inferior and buccal alveolar arteries, as well as by the masseteric, ascending palatal, mylohyoid, sublingual and submental arteries[10,14].

In the edentulous mandible, remodeling of the retromolar area is observed and the alveolar bone is resorbed, without exceeding the insertion of the mylohyoid and buccinator muscle, and blends with the overlying soft tissues including the retromolar pad[45,46]. This leads to a change in the shape of the RMT in the transverse and longitudinal diameter which are not always the same on the right and left side. Thus, it is possible to recognize an oval and triangular shape with a larger diameter than the round shape. Because the retromolar pad is preserved, it represents an important landmark in the lower dental prosthesis in edentulous patients and, if well registered, contributes to the prosthetic stability, especially for the oval and triangular shape[46].

From a pathological point of view, because oral hygiene is difficult in this distal area, periodontal pathologies with pockets and mobility of the last tooth can often be diagnosed, caused by deep periodontal pockets of its distal surfaces[14,18].

Most severe pathologies related to this region seem to originate from traumas of the mucosa which can be of a mechanical traumatic type, due to incongruous dental prostheses or teeth with sharp surfaces, physical or chemical from alcohol and tobacco, infectious such as from papilloma virus, or of a multifactorial type. These pathologies can, indeed, result in squamous cell carcinoma, often misrecognized[44]. In RMT it is possible to find injuries caused by mechanical trauma, such as direct trauma from a hyper-erupted tooth or from dental prostheses, or from fractured teeth, or from tobacco and/or alcohol-abuse. These injuries can evolve in leukoplakia, which is considered a pre-cancerosis[47]. This must be distinguished from yeast infection, that generally spread throughout the oral mucosa, and from benign alveolar ridge keratosis, often occurring in RMT and that could, optionally, lead to squamous carcinoma in predisposed subjects and as a consequence of continued trauma[48]. Erythematous lesions such as erythroplakia may also be present in RMT. This is considered a premalignant red variant of oral leukoplakia with similar etiology and pathogenesis[49]. In RMT carcinomas often are shown to originate from the tonsillar anterior arch[50]. The proximity of the two regions may not allow to recognize the primary site and, therefore, they are often classified together [13].

RMT can be also the site of benign and malignant pathological tumors[44,51], while either tumors affecting this area are more rare, as those originating from the minor salivary glands[52]. The Fordyce spots have no pathological significance and should not be confused with candidiasis[17]; they also have been associated with an inherited syndrome that predisposes to colon cancer (S. of Lynch)[53].

The follicular sac tissue or other structures of dental germ of the lower third molar may leave residues which can give rise to odontogenic cystic or tumoral pathologies in this area[54,55].

5. Conclusions

The area behind the lower wisdom tooth could be indicated as DALM, with two further sub-areas laying within it: RMT and retromolar "fossa".

We have given great relevance to a most detailed description of the most frequent types, number and site for most possible accessory canals that may occur as anatomical variants in such regions. Moreover, our study pinpoints the importance of a good knowledge of all DALM, RMT and retromolar "fossa", as well as how fundamental the clear awareness of their existence can be, due to several clinical correlations.

The same applies to RMC, which can be recognized via orthopantomography and confirmed in 3D renderings preliminary to oral surgery interventions. A particular attention to the presence of such canal (or canals) should be made especially in patients with coagulation problems undergoing interventions for the extraction of an impacted molar, or bone grafts, when exactly DALM (RMT, RM fossa and RMC) area is considered as donor site. Furthermore, a good knowledge of the anatomy of this region can enable clinicians to fore view possible ways of spreading of pathological processes such as abscesses and cystic-/odontogenic tumors, as well as precancerous or carcinomatous lesions, but also of complications related to both development and clinical evolution of the third lower molar.

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