

Sophie-Myriam Dridi, Michel Chousterman, Marc Danan, Jean François Gaudy

## Haemorrhagic risk when harvesting palatal connective tissue grafts: a reality?



**Sophie-Myriam Dridi**  
Assistant Professor,  
DDS MS, Department of  
Periodontology,  
University  
Paris René Descartes,  
France

**Michel Chousterman**  
Clinical Instructor,  
Department of  
Periodontology,  
University Paris René  
Descartes,  
France

**Marc Danan**  
Assistant Professor,  
DDS MS,  
Department of  
Periodontology,  
University Paris René  
Descartes,  
France

**Jean François Gaudy**  
Professor, Department of  
Anatomy,  
University Paris René  
Descartes,  
France

**Correspondence to:**  
Professeur Jean François  
Gaudy,  
Université Paris René  
Descartes,  
Laboratoire d'Anatomie  
Fonctionnelle,  
1 rue Maurice Arnoux,  
92100 Montrouge,  
France

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When obtaining good clinical results using connective tissue submerged grafts, the vast majority of authors place great emphasis on the surgical techniques carried out. However, few studies have shown the complications that may arise during such interventions. Although complications may not be frequent and are not life-threatening, these complications do exist. These complications generate anxiety for practitioners. Those that are regarded with most apprehension are peri- and post-operative haemorrhage, and this occurs due to the physiological vascularisation density of the palatal mucosa.

Through a study of the human anatomy, the authors verified the correlations that could exist between the morphology of the hard palate and the distribution of the greater palatine pedicle and, furthermore, if they were determining factors in choosing therapeutic options.

This study comprises two sections relating to applied anatomy: osteology (part 1) and dissection (part 2). Part 1 involved 30 maxillas presenting various forms and edentitions. Observations were carried out to compare the relationship between the line of the greater palatine pedicle, the morphology of the palate, and the effects of osseous remodelling associated with extractions and the installation of removable prosthesis. Part 2 was carried out on 12 fresh human cadaver maxillas. After injection of the arterial system with coloured latex, the specimens were dissected to observe the distribution of the greater palatine pedicle of the palate.

Anatomical surgery was carried out on two palates with different morphologies and different tissue harvesting techniques were performed. This allowed the authors to first specify the vascular distribution pattern of the palate, and to evaluate the relation between the sample zones and the branches of the greater palatine pedicle, to finally establish rules to help prevent haemorrhage from occurring.

### ■ Introduction

In the present day, periodontists recognise connective tissue submerged graft techniques as reliable and reproducible operative techniques. These techniques are indicated for a number of procedures and

are applied to both dentulous and edentulous sectors; in periodontal plastic surgery to cover denuded root surfaces and in preprosthetic surgery to thicken a gingival site or improve the crestal volume<sup>1,2</sup>. They are also indicated to create a favourable mucosal peri-implant environment<sup>3</sup>.



Different surgical protocols are well documented, as are publications recording clinical results and long-term aesthetic outcomes.

Hence, connective tissue submerged graft techniques can be considered as standard interventions in periodontics. Nevertheless, these operative techniques are difficult to perform and present a certain number of complications, particularly on the palatal donor site that remains as the privileged region for tissue harvesting. Griffin et al<sup>4</sup> reported the possibility of pronounced pain, delayed healing situations, necrosis of the harvested zone and sensitivity disorders. However, the complication that is regarded as the most serious is haemorrhagic accident due to injury of a vascular trunk<sup>5</sup>. When this occurs peri-operative bleeding is abundant, stressful for the patient and difficult to arrest by the practitioner. Further complications arise with the risk of submucosal haematoma that can become secondarily infected.

To better preserve the vascularisation and innervation of the hard palate, the harvesting procedure has become more accurate over the years<sup>6-9</sup> and a classification of incisions has been recently proposed<sup>10</sup>.

The detailed and meticulous analysis of the hard palate anatomy is crucial in the choice of the operative technique. With regard to the location of the principal vascular branches, two fundamental notions seem to be drawn from available anatomical studies<sup>11-14</sup>.

The first notion determines the existence of the 'palate at risk', according to the depth of the hard palate, which varies among individuals and in relation to the degree of alveolar resorption<sup>15</sup>.

The second notion emphasises the presence of 'risk zones' according to the thickness of the palatine fibromucosa. This varies among individuals and depends upon individual palatal regions<sup>12</sup>. It is thicker at the premolar and canine area, finer compared with the mesio-palatal root of the first molar and it becomes thinner with age<sup>15</sup>.

Through this study, the authors verified whether or not the data were pertinent, anatomically based and could really serve as a basis for reflection by the clinician.

Several recommendations were also suggested to decrease the risk of peri- and post-operative haemorrhage.

## ■ Materials and methods

### ■ Anatomical study

#### *Osteology study*

Thirty maxillary palatal bones from freshly prepared samples in the anatomy laboratory were examined. Two samples were completely edentulous, whereas the other samples generally presented partial or complete edentitions. The location of the greater palatine foramen, extent and importance of the indentation of the greater palatine pedicle on the palatal bone and morphological palatal modifications in edentulous subjects who wore a prosthesis were observed.

#### *Anatomical dissection*

Twelve maxillary blocks from fresh human cadavers whose vascular network was injected with coloured latex were isolated.

A curved mucosal incision was carried out from the posterior border of one maxillary tuberosity to the other, crossing the posterior nasal spine. This incision was completed by a crestal incision on edentulous sites and on the palatal mucosa tangential to the cemento-enamel junction (CEJ) from one tuberosity to another.

The superficial outline of the mucosa was retracted anteroposteriorly leaving the neurovascular pedicle in place.

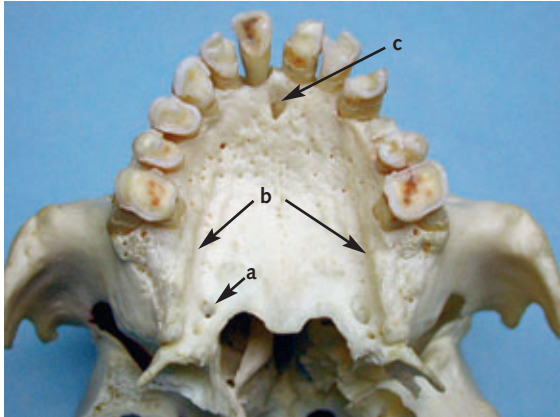
The submucosal connective tissue was then scraped off using a Walkman curette to visualise the location and distribution of the pedicle.

### ■ Anatomical surgical protocol

Two maxillary blocks from fresh human cadavers whose arterial network was injected with coloured latex were selected. Two palates of different depths using the Reiser classification were chosen<sup>14</sup>. In this classification, the hard palate is considered high in depth if the distance between the neurovascular elements and the CEJ of teeth 15 and 16 is 17 mm. It is said to be average in depth if the distance is 12 mm and shallow or flat if the distance is just 7 mm.

Palate number 1 was considered average in depth. Teeth 17 to 27 were present. Palate number 2 was flat and presented lateral edentulous zones.

To evaluate the depth of the palate, the greater

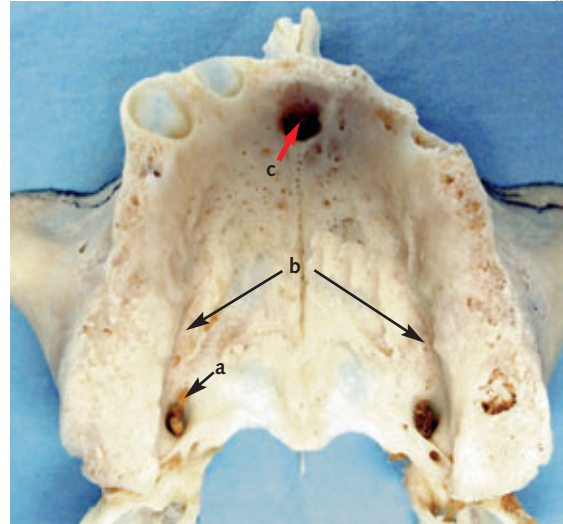


**Fig 1** Palatal view of a dentulous subject showing the location of the greater palatine foramen and the osseous line of the greater palatine pedicle. Identified landmarks: (a) greater palatine foramen, (b) descending palatine artery groove, (c) incisive foramen.

palatine foramen were first localised before virtually plotting a straight line until the inter-incisive point. The number of millimetres between the straight lines and the CEJ was then estimated. From 17 to 12 mm, the palate was considered to be high, from 12 to 7 mm as average and <7 mm as flat.

For each palate, at the level of the lateral section that was best preserved, two connective tissue harvests were performed according to the Bruno technique<sup>8</sup>; first in the anterior region of the hard palate (distal to the central incisor, distal to the first premolar), and second in the posterior palatal region (mesial to the second premolar, distal to the first molar). Numerous authors practise the Bruno technique, because it prevents the lifting of a mucosal flap, and this minimises post-operative complications. Several incisions were necessary; two horizontal incisions defined the length of the graft. They were parallel to each other, apart by 1 to 2 mm and at a distance of around 1 mm from the gingival margin border.

For the incision closest to the CEJ, the surgical blade was positioned perpendicularly to the tooth axis up to the bone. For the most apical incision, the blade was inserted parallel to the palatal fibromucosa and dissected several millimetres before regaining bone contact. Two vertical incisions on the mesial and distal as well as an apical horizontal incision completed the graft harvesting, which was previously separated from the bone using a surgical blade. A delicate dissection of each half of the hard palate was then performed to verify the dimension and location of the principal trunk of the descending palatine



**Fig 2** Partially edentulous maxilla with minimally resorbed large crests. The palate is deep. Identified landmarks: (a) greater palatine foramen, (b) descending palatine artery groove, (c) incisive foramen.

artery in relation to the incision lines. For the other lateral section of the dentulous palate, an epithelial connective tissue graft was harvested in the area of the premolars and the first molar. Four incision lines using a surgical blade, delineated a rectangle (the most coronal incision must be at 1.5 to 2 mm from the CEJ). The depth of the incisions was determined by the blade bevel that entirely penetrated into the fibromucosa. The dissection of the graft was always parallel to the mucosal surface. For palate number 2, due to the poor quality of the palatal fibromucosa on the second lateral part, an epithelial connective tissue graft was not harvested.

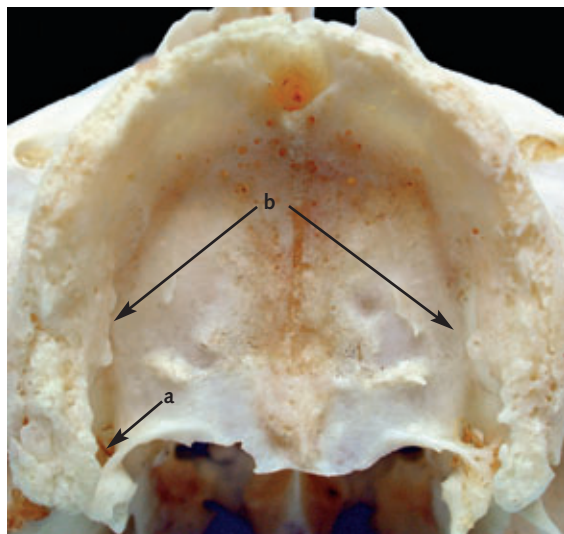
## ■ Results

### ■ From the anatomical study

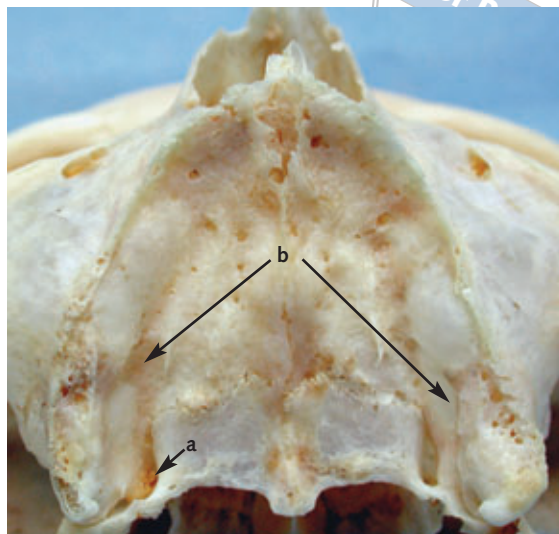
On bone samples (Figs 1 to 5) the greater palatine foramen presented a very stable location: 12 to 13 mm from the maxillary tuberosity crest and 3 mm in front of the posterior border of the hard palate.

The indentation of the greater palatine pedicle on the osseous palate is always present and disappears progressively at the level of the second premolars even in edentulous subjects (all removable denture wearers). The disappearance of the palatal osseous contours was observed in subjects presenting advanced crestal resorptions.

On dissections (Figs 6 to 12) the same reproducible location of the greater palatine foramen was



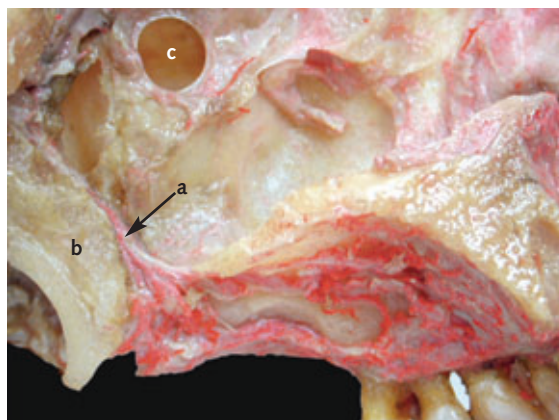
**Fig 3** Completely edentulous maxilla, complete denture wearer. The palate is less deep. Despite of the resorption, the osseous pedicle groove is quite visible. Identified landmarks: (a) greater palatine foramen, (b) descending palatine artery groove.



**Fig 4** Completely edentulous maxilla, complete denture wearer. Advance resorption of the crests, but the osseous pedicle groove is quite visible. Identified landmarks: (a) greater palatine foramen, (b) descending palatine artery groove.



**Fig 5** Palatal view of an edentulous subject wherein the palatal contours have been smoothed due to wearing a temporary prosthesis.

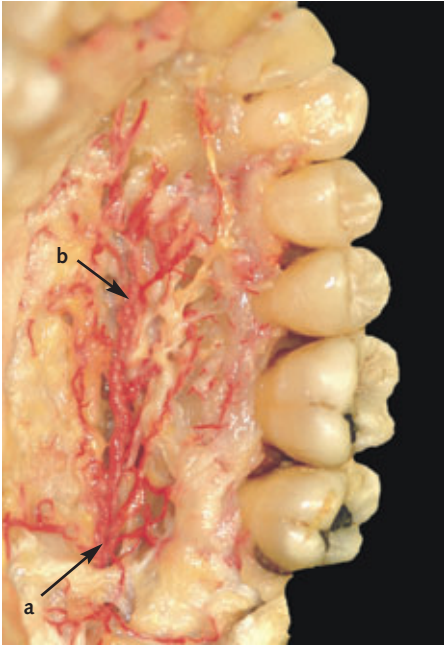


**Fig 6** Medial view of a hemi-maxillary block showing the greater palatine pedicle in the greater palatine canal and its palatal distribution. Identified landmarks: (a) pedicle in the canal, (b) medial wing of the pterygoid process, (c) hiatus of the maxillary sinus.

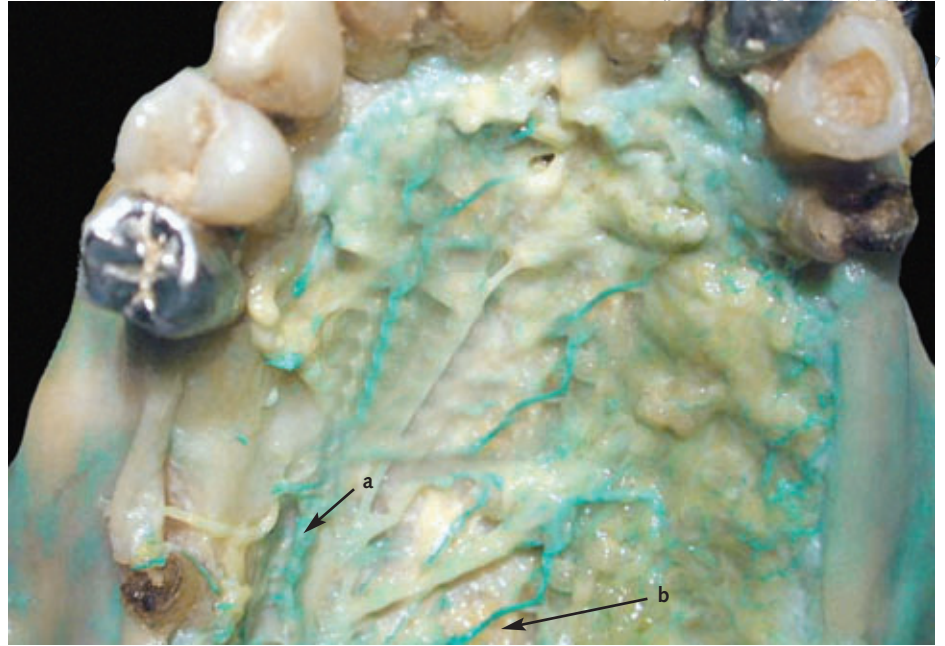
observed. On the 3 subjects the descending palatine artery was formed at its emergence of the foramen by a principal trunk of 0.7mm by 2 to 3 cm, supported by a much more slender trunk that then projected numerous mucosal ramifications.

On all other subjects, from its emergence, the

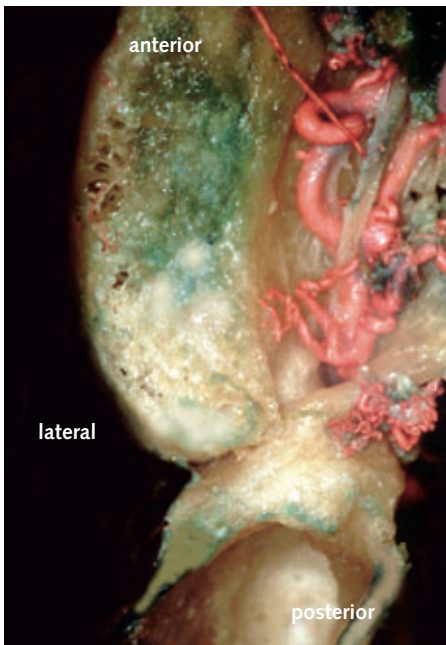
descending palatine artery divides in several terminal branches of diverse calibres (between 0.2 and 0.4mm). The arterial branches are always parallel to the axis of the alveolar crest. The voluminous branches, protected by the overhanging bone, are always in contact with the bone.



**Fig 7** Palatal dissection of the greater palatine pedicle in a totally dentulous subject. Identified landmarks: (a) here the pedicle is divided into three branches at the exit of the foramen, (b) the median branch is the largest and at a distance from the CEJs of the teeth.



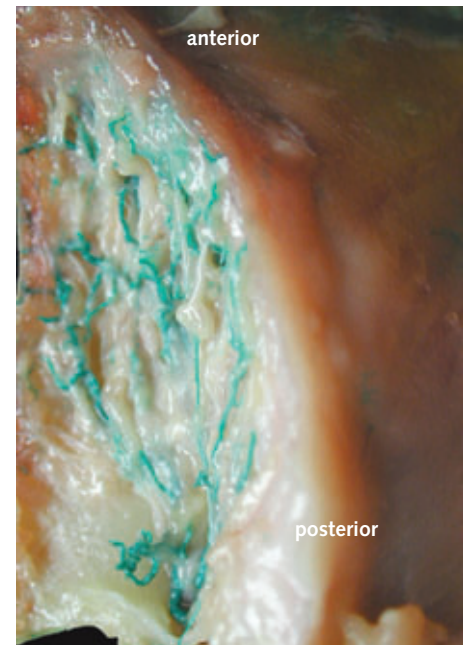
**Fig 8** Dissection of the greater palatine pedicle in a partially edentulous subject. Identified landmarks: (a) here the pedicle is divided into two trunks, one of which is voluminous and parallel to the dental arch, (b) the other is much more slender.



**Fig 9** View of the maxilla after erosion showing the greater palatine pedicle. Here a bigger principal trunk (0.8 mm) exists with the accessory branch rapidly ramifying.



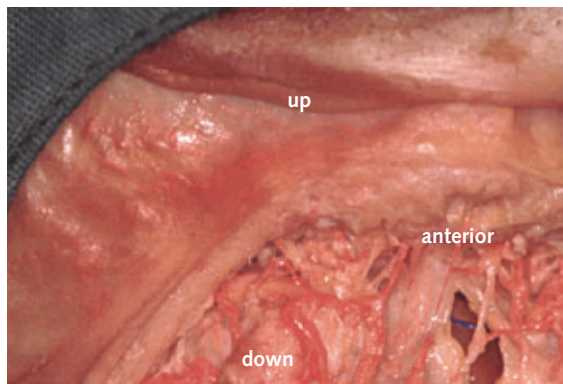
**Fig 10** Dissection of a left greater palatine pedicle, which presents at its emergence several branches of neighbouring calibre.



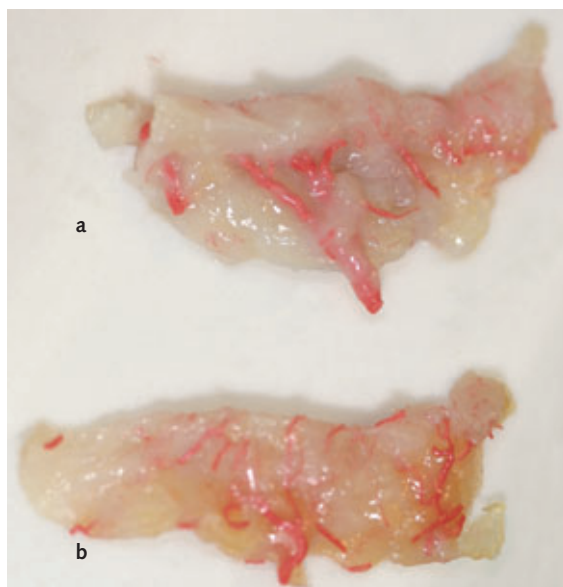
**Fig 11** Dissection of a left greater palatine pedicle presenting a palatal network consisting of several very fine branches.



**Fig 12** Dissection of a greater palatine pedicle from the incisive region showing the density of the vascular network at this level.



**Fig 13** Palate number 1, teeth 17 to 27. Incision lines for the two harvested connective tissue grafts. Harvesting was done in the posterior section of the hard palate (mesial of 25, distal of 26). The other was done in the anterior region (distal of 21, distal of 24).



**Fig 14** Palate number 1. Connective tissue grafts after removal of the coronal epithelial section. The graft originating from the anterior section of the palate (a) has less adipose and presented larger vessels than the graft from (b) the posterior section.



**Fig 15** Palate number 2. Incision lines for the posterior connective tissue harvest.

■ **From the anatomical surgical protocol**

For each palate, two connective tissue grafts of about 15mm x 6mm, were obtained, one in the anterior part and the other in the posterior part of the palate (see anatomical surgery protocol). These comprised numerous vascular ramifications (Figs 13 to 15).

From the initial dissection of the palatal lateral sections, it was clearly observed that an important quantity of adipose tissue overextends to the apical limits of the harvested grafts. The adipose mass is more abundant in the posterior zones (Figs 16 to 17). However, if these observations are valid for the two palates, it must be emphasised that palate number 2 presented a fibromucosa much finer than palate number 1.

As for the apical limit of the posterior harvested grafts, it was situated at the extension of the greater palatine foramina. Once the palatal dissection was concluded, vascular pathways were easily detectable.

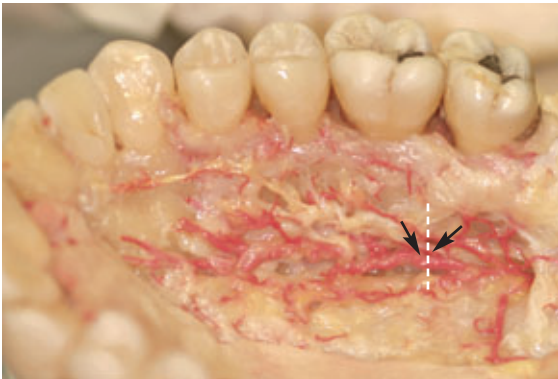
For palate number 1, the principal trunk of the descending palatine artery emerged in the posterior lateral section of the greater palatine foramen, it continued its pathway in a linear fashion into an osseous groove until it reached the retroincisive zone. It then ramified into numerous collateral branches that covered the entire region of the hemi-palate. With regard to the location of the greater palatine foramen, the trunk was located more apically towards the centre of the palate. Its average calibre was



**Fig 16** Palate number 1. Beginning of the dissection of the lateral half of the palate. At the apical limits of the two tissue harvests, an important quantity of adipose tissue was observed especially on the posterior region.



**Fig 17** Palate number 2. Beginning of the dissection of the lateral half of the palate revealing the apical limits of the tissue harvests.



**Fig 18** Palate number 1. End of the dissection of the lateral half of the palate. The descending palatine artery is clearly visible. It is situated 12 mm from the CEJ of tooth 26 and 4 mm from the apical limit of the posterior harvest. The greater palatine nerve is situated just above the artery.



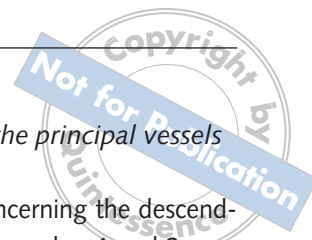
**Fig 19** Palate number 2. End of the dissection of the lateral half of the palate. The descending palatine artery presents a larger calibre than that of the palatine artery of palate number 1 and its pathway is more convoluted. It is situated 9 mm from the CEJ of the molar present in the arch.

0.6 mm in the premolar-molar zones, slightly decreasing in the anterior palatal zone. It was 12 mm away from the CEJ of the first molar and 4 mm from the apical incision line of the posterior harvest (Fig 18). For the anterior harvest, the mesioapical limit was adjacent to the anterior endings of the descending palatine artery.

The greater palatine nerve was also clearly visible. It emerged like the descending palatine artery to the greater palatine foramen to distribute itself into several anterior branches. The principal branch was situated more coronally to that of the palatine artery. Thus, it was closer to the apical limit of the posterior harvest.

For palate number 2, the principal trunk of the descending palatine artery presents a different path-

way and calibre in comparison with the artery of palate number 1. Once it emerged from the greater palatine foramen, it ran towards the incisive region in a convoluted manner, and was positioned slightly more apically compared with the location of the greater palatine foramen. Its calibre was more significant as it approached 0.8 mm and its collateral branches were less numerous and finer. Moreover, the trunk was not located in an osseous groove. The minimum distance between the trunk and the CEJ borders was 9 mm (Fig 19). For half of the posterior harvest zone, the apical limit is very close to the principal trunk of the palatine artery. Collateral branches, on the other hand, line the anterior harvest zone.



On the second lateral section of palate number 1, a 15 mm x 6 mm epithelial connective tissue graft was harvested. It was less vascularised than connective tissue grafts and did not include adipose tissue. The incision lines were superficial, thus very far from the trunk and principal collateral branches of the descending palatine artery.

## ■ Discussion

### ■ Connective tissue grafts

The size of the graft taken from the two subjects was predetermined to avoid lesion to the descending palatine artery, which would have prevented the authors from dissecting correctly. Therefore, the dimensions of the tissue harvests were reduced. However, it remained acceptable. Clinically, it would be possible to cover a denuded root without any problem.

For all grafts, adipose tissue was found in the apical section. This observation was compatible with the histological studies, which revealed the frequent presence of adipose tissue in the deep connective tissue<sup>16</sup>.

In periodontal plastic surgery, the extent of the apical harvest is of less interest as the adipose tissue must be removed or it will prevent the neovascularisation during healing of the recipient site.

The thickness of the grafts were thin. However, a good section of the connective tissue was harvested. From the beginning of the dissection of the hard palate, the osseous surface was already distinctly visible. The poor thickness of the fibromucosa is in relation with the anatomical samples origin and its conservation process. In human cadavers, a retraction of the mucous was observed.

Moreover, the thickness of the fibromucosa of palate number 2 was much less than that of palate number 1. Given the presence of edentitions, the authors thought that palate number 2 belonged to a much older individual than the individual with a dentulous palate.

Furthermore, it was thought that the individual probably wore a removable prosthesis, which compressed the mucosa. The dilatation of the ostia of the accessory salivary glands of the palate indicated that the individual was a smoker.

### *Concerning the location of the principal vessels supplying the palate*

The authors' observations concerning the descending palatine arteries of palate number 1 and 2 concurred with the results of the applied osteology and anatomical studies.

The descending palatine arteries ensure the totality of the palatal vascularisation. Collateral branches of the descending maxillary arteries emerge from the posterolateral sections of the palate at the greater palatine foramina. In general, their average calibre was from 0.6 to 0.8 mm<sup>15</sup>. The authors also obtained the same measurement. Each artery ramifies into numerous collateral branches, which supply beyond the lateral sections of the palate. The two arterial regions principally overlap each other and stretch forward until the retroincisive zone. The possibility of ramifications, on the contrary, was varied.

The palatine artery advances in most cases into a shallow groove in the bone, which provides a protective role, but is not standardised and may sometimes be absent (as was observed in palate number 2). This situation is more risky. Unfortunately, there is no viable clinical means of identifying if the artery is protected before starting an intervention. Whatever their size, the principal vascular trunks advance in a more apical position than the greater palatine foramen.

The innervation of the hard palate follows the arterial pathways. It is essentially supplied by the greater palatine nerves, which emerge like the descending palatine arteries in the greater palatine foramina, to be distributed into several anterior branches. For the two palates that were chosen, the nerves advanced parallel to the palatine arteries in a more coronal position. Therefore, the risk of damage occurring is higher.

### *The haemorrhagic risk*

During harvesting of a connective tissue graft, the operative risk that is most dreaded by clinicians is the occurrence of a haemorrhage<sup>5</sup>.

In relation to the anatomical data, it is reasonable to say that the haemorrhage involves mostly the collateral branches.

The lesion of a principal trunk of a palatine artery is actually rare, because the trunk is generally found in the groove, which is frequently lined by overhanging osseous projections that constitute a real natural





**Fig 20a to c** Connective tissue graft harvesting in a patient: (a) clinical view of incisions situated between the lateral incisor and the canine, (b) completely dissected graft harvest, (c) suture of donor site to ensure haemostasis.



**Fig 21a to b** Recommendations in case of sudden haemorrhage: (a) compression of the greater palatine foramen, (b) anatomical connection of the compressed zone (instrument artificially added on the image).

protection. However, an accidental injury causing necrosis to the palatine mucosa is possible, especially if the artery is not protected or if the palate is flat. The after-effects are often very limited though, given the interpenetration of the arterial regions and the existence of a complementary vascularisation supplied by both the ascending pharyngeal artery (branch of the external carotid) and the ascending palatine artery (branch of the facial artery).

However, to prevent any risk of injury to the arterial trunk during tissue harvesting in the postero-lateral section of the palate, the authors propose a simple procedure: before starting the incisions, imagine a line from the greater palatine foramen towards the inter-incisive point, which will be the virtual apical limit and the tissue will not be harvested beyond this line.

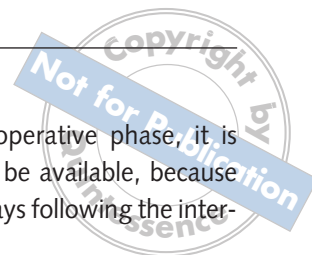
This clinical precaution is particularly valid for average and flat palates. It is simple to apply as the foramen can be easily palpated. Similarly, it is suitable to harvest in the premolar regions because their CEJs

are far from the arterial trunk in comparison with those of the molars.

Harvesting in the anterior section of the palate is also a solution (Figs 20a and b).

By applying these rules to the anatomical samples, it was verified that the apical limits of the incision lines of all the connective tissue harvest zones were clearly at a distance to the principal arterial trunks. The collateral section of the descending palatine artery can nevertheless provoke major peri-operative bleeding. The risk incurred in this situation is the formation of a submucosal haematoma, which can become secondarily infected.

If abundant bleeding occurs, it is recommended that pressure is put on the greater palatine foramen area with the aid of a blunt instrument. This will significantly reduce the flow of bleeding and enable the clinician to view the haemorrhagic origin (Fig 21). It is then necessary to perform suture points to bring the incision lines closer (Fig 20c). Suspending sutures



around teeth are sometimes useful. Sutures allow the obliteration of the vessels by compression of the region where it is located. It is, in fact, impossible to individually localise the palatine vessels for ligation.

The operated zone must be compressed firmly and persistently. The placement of a periodontal dressing around teeth will assure compression for several days. A preoperative fabricated plastic stent covering the hard palate should also be planned to ensure a durable palatine compression after the surgery.

Some authors recommend the use of haemostatic substances such as oxidised regenerated cellulose or gelatine sponge<sup>5</sup> for the harvest sites. The prescription of tranexamic acid mouthwash is equally recommended. In the case of an epithelial connective tissue graft, the haemorrhagic risk is almost nil as the wound is superficial.

## ■ Conclusions

The haemorrhagic complications following a palatal harvest of the connective tissue are infrequent, but are always difficult to manage.

Several precautions allow these complications to be avoided. During the preoperative phase, the examination of the site is fundamental because the neurovascular elements must be respected. Knowledge of the palatal anatomy and its vascularisation is compulsory. Flat palates can be considered at a higher risk for haemorrhagic complications than average or high palates. During the peri-operative phase, it is important to work in good conditions (e.g. efficient suction, good visibility) and to perfectly master the operative technique in order to perform a good harvest. To avoid injury to the principal trunk of the descending palatine artery, it is recommended to harvest in a zone coronally situated from the line passing from the greater palatine foramen and the inter-incisive point. Under this line, the risk of haemorrhage is equally as important as the quantity of the adipose tissue. Likewise, the choice of harvest sites must favour the premolar or incisive-canine regions. Molar regions are more dangerous.

In the case of abundant and persistent bleeding, it is imperative to suture the wound to avoid the occurrence of a submucous haematoma and to ensure compression of the operated zone.

Finally, during the post-operative phase, it is important for the clinician to be available, because bleeding can occur hours or days following the intervention.

This bleeding suggests incorrect haemostasis, mobilisation of the wound by tongue movements, by early and repeated rinsing of the mouth, or the existence of an undiagnosed haemostatic anomaly during the preoperative phase.

Respecting these safety precautions is important for the practitioner so as to ensure that the clinical obligations are fulfilled.

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