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Case presentation

Graphite oral tattoo: case report

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Abstract

Pigmented oral lesions compose a large number of pathological entities, including exogenous pigmentations, such as amalgam and graphite tattoos. We report a rare case of a graphite tattoo on the palate of a 62-year-old patient with a history of pencil injury, compare it with amalgam tattoos, and determine the prevalence of oral tattoos in our Oral Pathology Service. We also compare the clinical and histological findings of graphite and amalgam tattoos. Oral tattoos affect women more frequently in the region of the alveolar ridge. Graphite tattoos occur in younger patients when compared with the amalgam type. Histologically, amalgam lesions present impregnation of the reticular fibers of vessels and nerves with silver, whereas in cases of graphite tattoos, this impregnation is not observed, but it is common to observe a granulomatous inflammatory response, less evident in cases of amalgam tattoos. Both types of lesions require no treatment, but in some cases a biopsy may be done to rule out melanocytic lesions or for aesthetic reasons.

Introduction

Pigmented oral lesions may be of an endogenous or exogenous nature. Among the lesions of exogenous origin, the most frequently found are amalgam tattoos, followed by graphite tattoos. Graphite tattoos mainly result from accidental injury involving pencils, in which graphite from the tip of the pencil is inserted into the oral mucosa. Reports of these cases are scarce in the literature because these generally are innocuous and do not require a biopsy except when melanocyte proliferations are considered [1]. The graphite tattoo occurs predominantly in women and youngsters from age 5 to 21 years, mainly in the region of the inserted gingiva and palate. The size is variable, generally from 1 to 15 mm, and macules are blue-gray in color [2-4]. Histologically, the graphite particles may be randomly distributed in the connective tissue or around vessels and along fibers. Inflammation may be absent, or graphite may induce a chronic inflammatory response with formation of foreign body granulomas exhibiting the presence of multinucleated giant cells [2-4]. These lesions require no treatment. In general, biopsy is performed to exclude other pigmented lesions, such as melanocytic nevus, blue nevus, and melanoma, or for esthetic reasons.

The aim of this study was to report a rare case of a graphite tattoo and compare it with amalgam tattoos. We also investigate the prevalence of oral tattoos in our Oral Pathology Service.

Case synopsis

The patient, a 62-year-old woman, presented to a community based outpatient dental clinic for a routine consultation. The patient related that at 13 years of age she had pierced her palate with the tip of a pencil. Her medical history showed nothing noteworthy. On clinical exam, a papule of a bluish gray color that faded at the periphery, measuring approximately 0.3x0.1x0.5cm, was observed on the right side of the palate, lateral to the midline. There were some petechiae around the papule, resulting from denture wearing (Figure 1). The patient could not give any information about her previous dental history or the presence of amalgam fillings prior to tooth removal and prosthesis placement. The clinical diagnosis was graphite tattoo and an excisional biopsy was performed to confirm the diagnosis.

Histopathology showed a fragment of mucosa covered by parakeratinized mucosal epithelium, under which the lamina propria of fibrous connective tissue could be noted to be permeated with blackened exogenous particles enveloped by granulation tissue and surrounded by large and multinucleated histiocytes. A moderate lymphocytic infiltration was also noted (Figure 2). The final diagnosis was exogenous pigmentation, compatible with graphite tattoo. In order to confirm the origin of the granules found in the histologic exam and to illustrate the case, energy dispersive x-ray (EDS) and scanning electron microscopy (SEM) were performed. For the EDS analysis, 5 μ m unstained and deparaffinized cuts without the cover slips were used. Analysis was performed using the Inspect S50 SEM (Fei, Hillsboro, Oregon, USA) appliance with Bruker detector, voltage 25kV and count per second above 1500. The images were captured with a secondary electron detector. In the EDS analysis, the presence of silica, magnesium, calcium, nitrogen, oxygen, sodium, and carbon was observed (Figure 3). For the illustrative analysis by SEM, the slides were metalized using gold alloy with 8nm thickness (Emitech SC7620, Fall river, Massachusetts) and the images were captured at a voltage of 20kV, at 430x magnification (Figure 4). Coarse granules were observed among the connective tissue fibers.

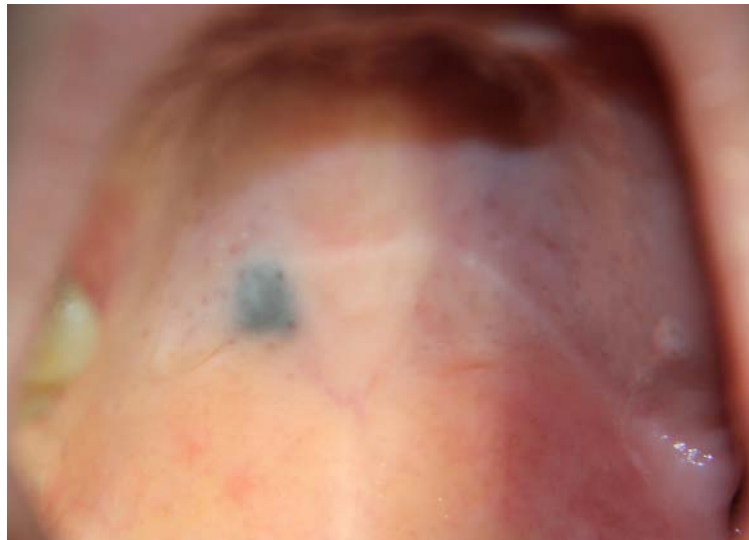


Figure 1. Clinical image of lesion: Note bluish-gray, oval papule with smooth margins in region of hard palate close to border with soft palate, measuring 0.3x0.1x0.5cm.

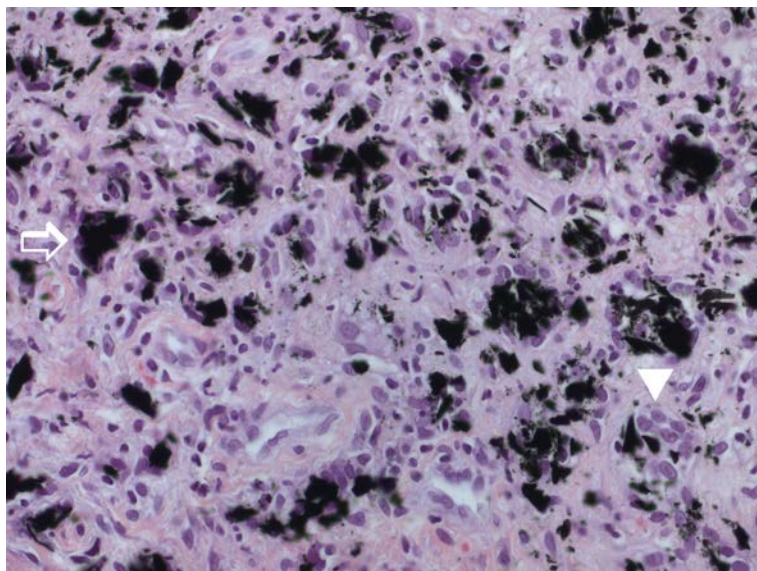


Figure 2. Graphite tattoo photomicrograph. Hematoxylin and Eosine (HE) staining. Original magnification 400x. Note deposition of blackened granules of variable size and irregular shape (arrow) in the midst of connective tissue with granulomatous inflammation. Multinucleated giant cells encircling the graphite granules are seen (tip of arrow).

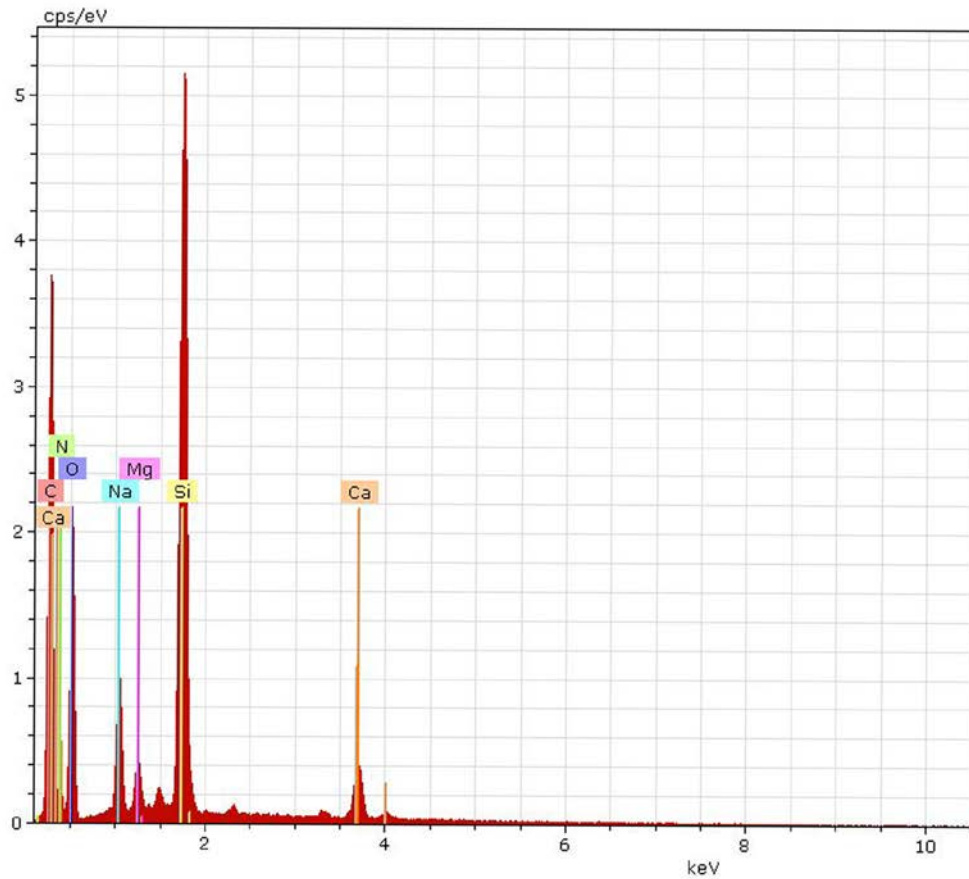


Figure 3. Electron dispersive spectrography analysis (EDS) of graphite tattoo slide: Note the peaks that represent the chemical elements, demonstrating the remarkable presence of silica, the material used for fabricating graphite used in pencil manufacturing.

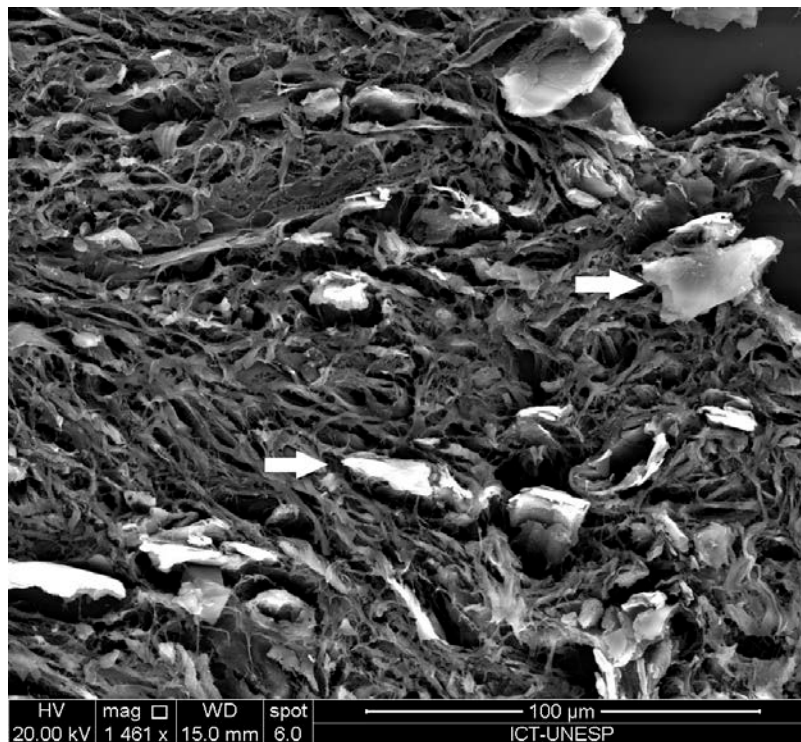


Figure 4. Scanning electron microscopy of case of graphite tattoo. Note graphite granules that exhibit variable diameter, irregular shape, and appear to be superimposed on connective tissue fibers (arrow).

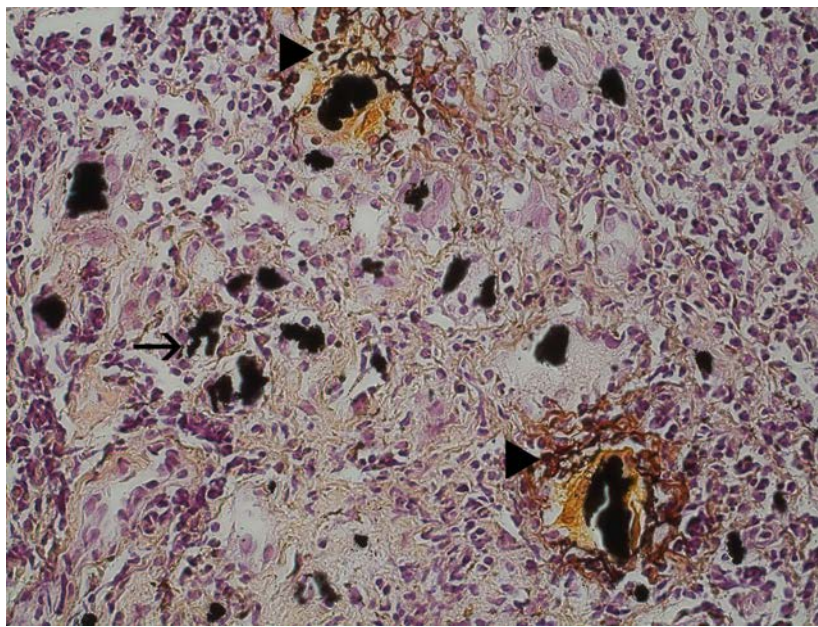


Figure 5. Photomicrograph of a case of amalgam tattoo from files of our institution. Hematoxylin and Eosine (HE) staining. Original magnification 400x; Note blackened granules distributed throughout connective tissue (arrow), being smaller and more regular when compared with those of graphite tattoo. Also note impregnation of elastic fibers of vessels and nerves with silver, giving them a brownish pigmentation (tip of arrow).

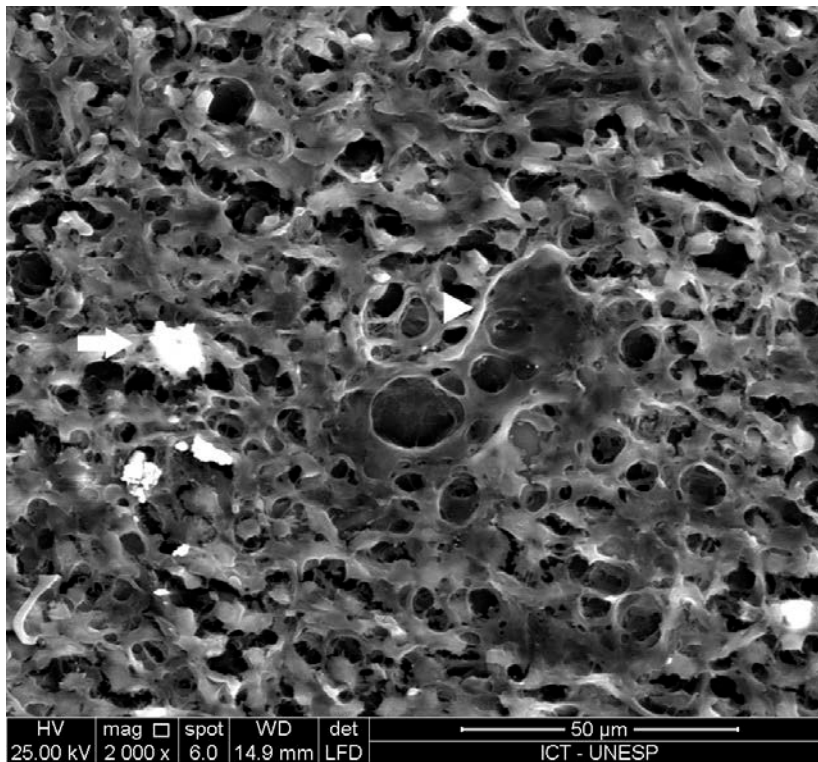


Figure 6. Scanning Electron Microscopy of a case of amalgam tattoo from files of our institution. Note deposition of granules along the connective tissue fibers (tip of arrow) and other coarser granules (arrow).

Analysis of the files

All the reports with diagnosis of "amalgam tattoos", "exogenous pigmentation compatible with amalgam tattoos", or "exogenous pigmentation compatible with graphite tattoos", in the oral pathology laboratory at our institution were selected from 1975 through to 2013. The criteria for diagnosis of amalgam tattoo were the presence or history of amalgam fillings associated with the presence of histological dark particles along connective tissue fibers and basement membrane of epithelium or blood vessels. In amalgam tattoo, reticulin fibers stain golden-brown and foreign body granulomas may be observed. For the graphite tattoo, the criteria for diagnosis included the presence of black granules of non-refractile, foreign material, some of which reside within multinucleated giant cells, with no fiber pigmentation. The history of accidents with pencils was important for the diagnosis.

Only 1 case of graphite tattoo (our case) and 99 cases of amalgam tattoos were found. This is out of a total of 12,274 cases, which represents 0.008% and 0.8%, respectively, of all the cases recorded on the service. Hence in our specimens, amalgam tattoos were 100 times more frequent than the graphite type. In the cases of amalgam tattoos, the lesions occurred in 63 women and 36 men, with a mean age of 48.58 years (min: 6; max: 81; standard deviation: 14.608). The main locations were the alveolar ridge (30.30%), gingiva (24.24%), buccal mucosa (20.20%), floor of the mouth (10.10%), retromolar region (6.06%), palate (3.03), and bottom of the superior vestibule (2.02%). The ventral part of the tongue, lip vermilion, bottom of the inferior vestibule, anterior faucial pillar, and dorsum of the tongue made up just 1.01% each. The main clinical diagnosis was amalgam tattoo (74.7%), followed by nevus (34.3%) and melanoma (16.2%). Other clinical diagnoses were also pointed out, such as melanotic pigmentation, melanosis, peripheral hemangioma, endogenous pigmentation, oral melanotic macule, and melanoacanthoma.

Discussion

Pigmented lesions represent a large group of oral pathologies that frequently present a diagnostic challenge since they may have a similar clinical appearance. Among the exogenous pigmented lesions, there are amalgam and graphite tattoos. Analyzing the literature, only three cases of graphite tattoos were found, all in the gingival region. These affected female patients, with a mean age of 14.3 years (Table 1). With reference to amalgam tattoos, 291 cases were found, with 61.5% having occurred in female patients, mean age of 44.8 years. Amalgam tattoos mainly affected the alveolar mucosa and 34% exhibited radiographic evidence (Table 2). Amalgam tattoo was reported 97 times more than graphite tattoos, showing evidence of the rarity of the latter lesion. For both types of lesion, the main treatment was biopsy. A retrospective examination of our pathology service materials also showed graphite tattoo to be a much rarer entity than amalgam tattoo.

The case reported is similar to those in the literature. Our patient was female and the lesion occurred during childhood. However, our patient's tattoo was the first case affecting the palate (Table 1). Amalgam tattoo in the palate is also rather unusual, with only 6 cases related [5,6]. When it occurs in the palate, the clinician may confuse these lesions with melanoma or melanocytic and blue nevus. Although rare, these are lesions that usually involve the palate [7,8].

The amalgam tattoo is the most common exogenous pigmented oral lesion, owing to the large scale use of amalgam as a restorative material. The pigmentation is caused by the introduction of amalgam into the soft tissues, which may occur during insertion of the material into the cavity or during its removal by injury to the adjacent tissue by the high-speed handpiece. In addition, particles may be dislodged during tooth extraction or may enter the surgical wound during endodontic treatment with retrograde filling [5]. The data from our clinicopathological study are similar to those found in the literature with regard to sex, age, and location of lesions.

A radiographic exam and patient's history may help with distinction between these two lesions. Amalgam tattoos with larger particles may appear as radiopaque points in the radiograph. However, if the particles are of a small diameter they will not be observed [5]. In addition, silver present in the amalgam alloy may be degrading, which would result in the disappearance of radiopacity after 1 year [6].

Histologically, amalgam and graphite lesions are very similar. Both present as dark granules of varying size. However, amalgam granules are more frequently arranged around and along the vessels, nerves, and collagen fibers in intimate contact with these structures [9](Figure 5). Graphite granules are usually coarser and trigger a more intense inflammatory response (Figure 2). Another method that may be used in determining the material causing the lesion is analysis by EDS. In amalgam lesions one observes the presence of copper, silver, sulphur, tin, and mercury [10-16], whereas in the graphite tattoo there is evidence of a larger quantity of carbon and silica. Graphite is a material made up of carbon, however, clay, which is rich in silica, is added for the manufacture of graphite used in pencils [9]. In SEM analysis it is also possible to observe the difference between the graphite and amalgam granules; in graphite the granules are larger and more irregular (Figure 4), the amalgam tattoo granules are smaller, more regular, and impregnate the connective tissue fibers (Figure 6).

The treatment of these lesions is by follow up observation, because they generally do not present any risk to the patient. However, a case has been reported [17] of a patient who presented with a firm, slightly elevated nodule of a brownish color in the oral mucosa, with symptoms of sinusitis and orofacial pain. There were radiopaque areas observed in the radiograph and excisional biopsy was performed. After removal of the amalgam, the patient related improvement in the systemic symptoms, leading one to believe that the symptoms resulted from the metals. In some cases, the location of lesions in the gingiva may cause the patient esthetic discomfort; in these cases surgery may be performed with a scalpel or laser [3,17,18].

In conclusion, the graphite tattoo represents a rare oral tattoo, which shares some clinical characteristics with the amalgam tattoo. However, the two types may be differentiated by means of clinical, radiographic, and histopathological exams, in addition to EDS analysis. This differentiation is of a merely academic nature, since the treatment for both types is observation, biopsy to exclude other pigmented lesions, and removal in cases of esthetic discomfort.

Table 1. Summary of published articles on graphite tattoos. F: Female. NI: not informed.

Authors	Sex	age	location	Size	Color	Treatment
Rihani and Da'ameh, 2006 [4]	F	5 years	Attached gingiva	15X5mm	Bluish-black	Biopsy
Anderegg and Lyles, 1992 [2]	F	21 years	Attached gingiva	1X2mm	Bluish-gray	Biopsy
Phillips and John, 2005 [3]	F	17 years	Interdental Papilla	NI	Grayish	Biopsy+Graft
Present Case	F	62 years	Palate	3x1x0.5mm	Bluish-gray	Biopsy

Table 2. Summary of published articles on amalgam tattoos. F: Female; M: Male; NI: Not informed; RO: Radiopaque

Authors:	Sex	Age (years)	Location	Size	Color	Radiograph	Treatment
Simon, Buchner and Bubis, 1972 [20]	F	47	Alveolar mucosa	NI	Black	NI	Biopsy
Barr, 1976 [21]	M	45	Alveolar mucosa	NI	Blackish-blue	RO Points	Follow-up
Buchner e Hansen, 1980 [5]	172F/ 94M	Mean 43.1	Inferior alveolar mucosa, oral mucosa, floor of the mouth	1 to 20 mm	Blue, black or gray	10 cases with RO areas	Biopsy
Mcginis, Greer and Daniels, 1985 [22]	M	13	Alveolar mucosa	3x5mm	Blue-black	NI	Biopsy
Weaver, Auclair and Taybos, 1987 [17]	F	33	Oral Mucosa	7X7 mm	Brown	RO Points	Biopsy
Martin <i>et al.</i> , 2005 [23]	F	60	Alveolar mucosa	8mm	Bluish-black	RO Points	Biopsy
Staines and Wray, 2007 [24]	F	54	Interdental Papilla	NI	Brown	Without alteration	Biopsy
Donetti <i>et al.</i> , 2008 [25]	F	58	Inferior gingiva	11x7 mm	Dark-brown	NI	Biopsy
Campbell and Deas, 2009 [18]	F	56	Alveolar mucosa	18 -10 mm	Bluish	NI	Biopsy+Graft+Laser
Parizi e Nai, 2010 [26]	F	46	Fornix	2mm	Black	RO Points	Biopsy
Amano <i>et al.</i> , 2011 [27]	F	63	Floor of the Mouth	9X6mm	Bluish-black	Without alteration	Biopsy
Dubach and Caversaccio, 2011 [28]	M	64	Buccal mucosa	NI	Bluish-black	NI	Biopsy
Galletta <i>et al.</i> , 2011 [29]	F	34	Alveolar mucosa	NI	dark blue	RO Points	Biopsy
Gojkov-Vukelic, Hadzic and Pasic, 2011 [19]	F	25	Alveolar mucosa	NI	NI	NI	Laser
Ricart e Martin, 2011 [30]	F	60	Alveolar mucosa	6mm	Bluish-black	NI	Biopsy
D'acunto <i>et al.</i> , 2012 [31]	F	45	Floor of the Mouth	6X3mm	Bluish-brown	NI	Biopsy
Grazzini <i>et al.</i> , 2012 [32]	Male	52	Floor of Mouth	5mm	Blue-gray	NI	Incisional biopsy
Vera-Sirera <i>et al.</i> , 2012 [6]	5F/ 1M	Mean 56.5	Gingival, buccal and palatal mucosa	3 to 10mm	Bluish-black	Without alterations	Biopsy
Lundin, Schmidt and Bonde, 2013 [33]	F	51	Bilateral buccal mucosa	NI	Dark-brown	NI	Biopsy

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