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Original Article

# Clinicopathological study of periapical scars

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## KEYWORDS

Periapical scar;  
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**Abstract** *Background/purpose:* Periapical scar (PS) is an alternative healing process with the formation of scar tissue after appropriate endodontic treatments/retreatments with or without periapical surgeries. This retrospective study evaluated the clinical, radiographic, and histopathological features of 7 PSs.

*Materials and methods:* The clinical, radiographic, and histopathological data of 7 PSs were collected and analyzed.

*Results:* The 7 PSs were taken from the maxilla (3 cases) and mandible (4 cases) of 3 men and 4 women. The most frequently involved teeth were maxillary or mandibular incisors (4 cases) and first or second molars (3 cases). Of 7 PS patients, 6 had none of symptoms, 5 had previous nonsurgical endodontic treatments/retreatments, and 2 had previous endodontic treatments/retreatments plus periapical surgery. Radiographically, all 7 PS cases presented as a persistent and well-defined periapical radiolucent lesion for a long period of time. Microscopically, all 7 surgical specimens of PS showed dense fibrous collagenous tissues with one having amalgam particles in the scar tissue.

*Conclusion:* PSs do have their common clinical and radiographic features. When the periapical radiolucent lesion is well-defined, persistent without a significant change of its size, and free from symptoms and signs after a long-term follow-up; the involved tooth has no evidence of

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root fracture and healthy periodontium except the periapical radiolucency; and the previous endodontic treatment/retreatment or periapical surgery is well performed with an adequate root canal or retrograde filling, then the PS may be a possible diagnosis and a close follow-up may be a more conservative treatment strategy for this condition.

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## Introduction

Periapical scar (PS) is a reparative response to a periapical inflammatory lesion with the formation of dense fibrous collagenous tissue instead of normal alveolar bone after an appropriate endodontic treatment/retreatment with or without periapical surgery.<sup>1</sup> The periapical lesions include mainly periapical granuloma, periapical cyst (radicular cyst), periapical abscess, and PS. Compared to periapical granuloma and radicular cyst, the PS is a relatively rare periapical lesion. In addition, the majority of previous scholars focused on the studies of periapical granulomas and radicular cysts.<sup>1–8</sup> The clinical, radiographic, and histopathological features of PSs are seldom investigated.<sup>9</sup>

The PS is basically a scar tissue that does nothing harm to the patient. However, the PS is often presented as a persistent periapical radiolucent lesion. Thus, it may be misdiagnosed as a radiographic sign of failed endodontic treatment and subsequently managed by retreatment or surgical removal of the lesion.<sup>6,7</sup> To avoid the unnecessary periapical surgery, it is very important to understand what clinical and radiographic features are common and suggestive of the diagnosis of a PS without the need of a histopathological examination of the surgically-removed tissue specimen.

In this study, we tried to report the demographic data, the common clinical features (including involved teeth, clinical diagnosis, patients' symptoms and signs, and previous endodontic treatments/retreatments or periapical surgeries), radiographic findings, and histopathological features (including fibrous connective tissue components and the presence of foreign bodies in the fibrous scar tissues) of 7 cases of PS. We hope that the common clinical and radiographic features of PSs reported in this study may guide the clinicians to make a diagnosis of PS and to reduce the unnecessary periapical surgery for the PS.

## Materials and methods

All the PS cases were retrieved from the archives of a private pathological center, Taipei, Taiwan from August 2020 to February 2021. The PS cases included in the study had to fulfill all the following criteria: 1) the histopathological diagnosis of a PS with available demographic data, clinical records, and tissue slides or blocks; 2) the patient having a periapical or a panoramic radiograph showing a radiolucent lesion at the periapical area of a tooth that had received endodontic therapy with or without periapical surgery; and

3) a microscopic finding of the specimen demonstrating fibrous collagenous tissue with no inflammation or a minimal chronic inflammation. The age and gender of patients, the involved tooth, clinical diagnosis, patients' symptoms and signs, previous endodontic treatment/retreatment or periapical surgery, and radiographic features of the PSs were reviewed and recorded from the pathological diagnosis requisition sheets.

All surgical specimens were obtained from curettage or enucleation of the periapical lesions. The removed tissue specimens were immediately placed into 10% neutral formalin and fixed for at least 24 h. They were then dehydrated in graded alcohol, and embedded in paraffin. The tissue blocks were cut into 5- $\mu$ m serial sections which were then stained with hematoxylin and eosin (H&E). Two oral pathologists independently performed the review of the diagnosis and analysis of the histopathological features based on microscopic examination of the H&E-stained tissue sections. The microscopic criteria for diagnosis of a PS included the finding of fibrous collagenous tissue with no inflammation or a minimal chronic inflammation. If there were foreign body materials in the specimen, the type and character of foreign body materials were identified with the help of the past dental history and sometimes a polarized microscope.<sup>10</sup> Microscopic findings suggestive or characteristic of other known pathologic entities were excluded from the current study. A double-headed light microscope was used to reach a consensus in cases where inconsistent pathological diagnosis and findings were encountered.

## Results

During the period from August 2020 to February 2021, 922 biopsy tissue specimens including 445 tissue specimens of periapical lesions (197 cases of periapical granuloma, 239 cases of radicular cyst, 8 cases of PS, and one case of periapical abscess) were sent to the pathological center for histopathological diagnosis. One PS case was excluded from this study because it had questionable endodontic origin. Thus, a total of 7 PSs (1.6% of 445 periapical lesions) were included in this study.

The 7 tissue specimens of PS were taken from the maxilla (3 cases) and mandible (4 cases) of 7 patients (3 men and 4 women, mean age  $51 \pm 15$  years, range 30–78 years). The male to female ratio was 1:1.3 (Table 1). The most frequently involved teeth were maxillary or mandibular incisors (4 cases) and first or second molars (3 cases). For all 7 PS cases, each involved one tooth (Table 1). Of the 7 PS cases, the clinical diagnosis was radicular cyst for 5

**Table 1** Demographic data and clinical and radiographic features of 7 cases of periapical scar.

Periapical scar	Patient age (year)	Patient gender	Involved tooth	Clinical diagnosis	Patients' symptom	Patients' sign	Previous endodontic treatment or surgery	Persistent periapical radiolucent lesion	Character and size of periapical radiolucent lesion (mm)
Case 1	50	Female	Tooth 42	Radicular cyst	None	None	Endodontic treatment and periapical surgery	+	Well-defined 4 × 3
Case 2	48	Male	Tooth 36	Radicular cyst	Mild pain	Mild redness and swelling	Endodontic treatment	+	Well-defined 10 × 8
Case 3	78	Male	Tooth 21	Radicular cyst	None	None	Endodontic retreatment	+	Well-defined 6 × 5
Case 4	30	Female	Tooth 37	Radicular cyst	None	None	Endodontic treatment	+	Well-defined 8 × 5
Case 5	39	Female	Tooth 16	Periapical granuloma	None	None	Endodontic retreatment	+	Well-defined 3 × 2
Case 6	59	Male	Tooth 41	Radicular cyst	None	None	Endodontic treatment	+	Well-defined 3 × 3
Case 7	56	Female	Tooth 12	Periapical granuloma	None	Fenestration of labial cortical plate	Endodontic retreatment and periapical surgery	+	Well-defined with radiopaque materials 5 × 5

cases and periapical granuloma for 2 cases (Table 1). The clinicians did not suspect PS in any one of these 7 PSs. In this study, 6 of the 7 patients had none of symptoms and only one patient complained of mild pain at the periapical area of involved tooth (case 2). Two patients had clinical signs, including one with mild redness and swelling (case 2) and another one with fenestration of the labial cortical plate at the periapical area (case 7, which was found during the periapical surgery) (Table 1). For the past dental history, 5 had previous nonsurgical endodontic treatment/retreatment and 2 had previous endodontic treatment/retreatment plus periapical surgery (Table 1). Radiographically, all 7 PS cases showed persistent and well-defined periapical radiolucent lesions for a relatively long period of time after previous nonsurgical endodontic treatments/retreatments with or without periapical surgeries. The size of the 7 radiolucent lesions ranged from approximately 3 mm–10 mm in greatest dimension (mean,  $5.6 \pm 2.6$  mm) on the periapical radiographs.

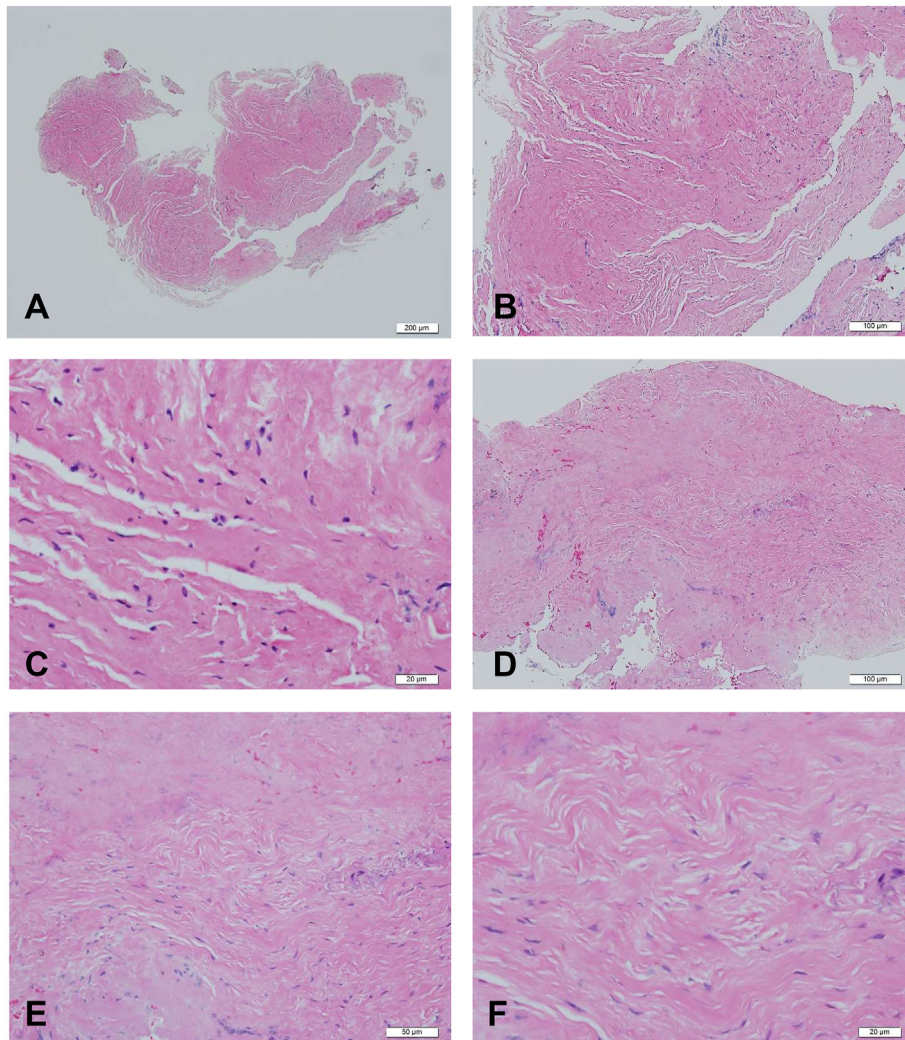
Histopathological features of 7 PSs are shown in Figs. 1 and 2. All 7 surgical specimens showed dense fibrous collagenous tissues with no inflammation or focal minimal chronic inflammation (Fig. 1). For the PS with a long duration, hyalinization of the fibrous connective tissue was observed (Fig. 1D, E and F). In one case (case 7) with a previous periapical surgery plus retrograde amalgam filling, aggregates of residual black amalgam particles were discovered in the dense fibrous connective tissue (Fig. 2A and B). Aggregates of small amalgam particles were surrounded by fibrous connective tissue with a more significantly mild chronic inflammatory cell infiltrate (Fig. 2C), but aggregates of large amalgam particles were surrounded by fibrous connective tissue with minimal chronic inflammation (Fig. 2D).

## Discussion

All the 7 PS cases in this study had the previous dental treatments including 5 with nonsurgical endodontic treatments/retreatments and 2 with endodontic treatment/retreatment plus periapical surgeries. In addition, all 7 PS cases had well-defined periapical radiolucent lesions for a relatively long period of time after previous dental treatments. The majority of these periapical radiolucent lesions persisted and did not cause any symptoms as time went by. However, the radiographic presentation of a periapical radiolucency is usually considered as a sign of endodontic failure and even worse as a possible primary or metastatic malignant lesion.<sup>11</sup> Therefore, the periapical surgery was performed by the doctors, the removed tissue specimen was sent for histopathological diagnosis, and finally a PS was confirmed histologically.

In this study, of 7 PS cases, 5 was clinically diagnosed as a radicular cyst and two as a periapical granuloma. The clinicians did not suspect PS in any one of these 7 PSs. Thus, when the periapical radiolucent lesion persisted without a significant change of its size and did not lead to any symptoms and signs after a long-term follow-up, a PS should be included in the list of differential diagnosis of this periapical lesion even though the occurrence rate of the PS is relatively low. The clinicians may consider the long-term follow-up as a treatment strategy for this specific condition until the next untoward event appears. In general, the quiescent PS should have no symptoms and signs, unless it acquires reinfection from intraradicular or extraradicular bacterial sources.

In this study, 6 (86%) of the 7 PS patients had none of symptoms, one had a mild inflammation including mild redness, swelling, and pain at the periapical area of the

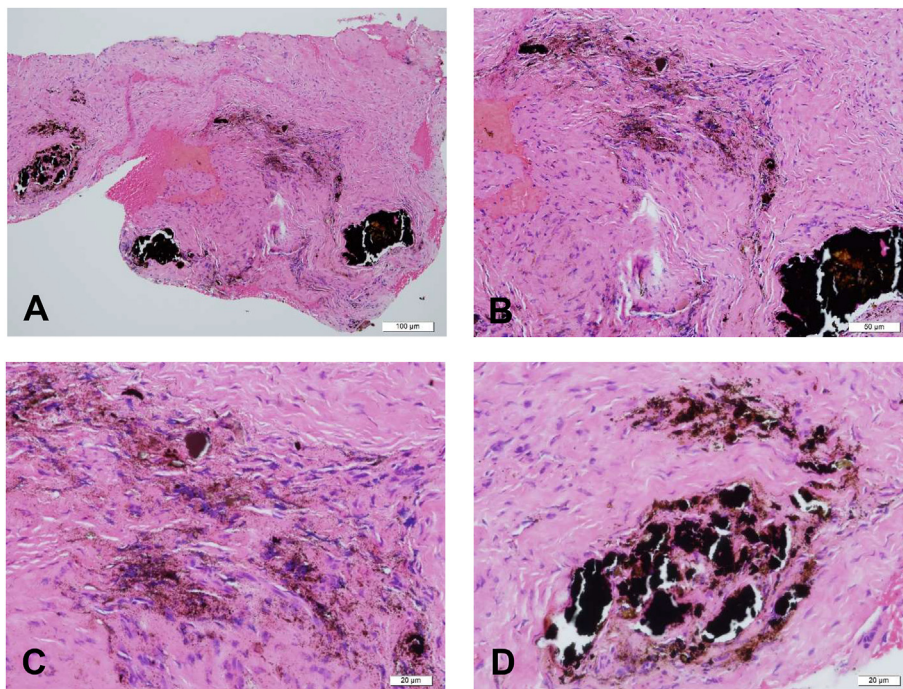


**Figure 1** Histopathological features of periapical scars (PSs). (A, B and C) Low-, medium-, and high-power microphotographs of a PS showing dense fibrous collagenous tissues with a few spindle-shaped fibroblasts scattered among collagen fibers and no inflammation. (D, E and F) Medium- and high-power microphotographs of a long-duration PS exhibiting dense fibrous collagenous tissues with marked hyalinization and fewer spindle-shaped fibroblasts than those seen in the PS specimen shown in A, B and C. (Hematoxylin and eosin stain; original magnification; A, 4 $\times$ ; B, 10 $\times$ ; C, 40 $\times$ ; D, 10 $\times$ ; E, 20 $\times$ ; F, 40 $\times$ ).

tooth 36 (case 2), and another one had fenestration of the labial cortical plate at the periapical area of tooth 12 (case 7, which was found during the periapical surgery). Peñarrocha et al.<sup>9</sup> studied the symptoms and signs of 32 PS cases before periapical surgery. They found that 25 (78.1%) PS cases are asymptomatic and 22 (68.7%) have no alteration in the soft tissues at the periapical area of involved tooth, but 6 (18.7%) produce swelling and 4 (12.5%) have fistulation. Because the major etiology of post-treatment apical periodontitis is intraradicular infection from the bacteria persisting in complex apical root canal system or missed root canals or a secondary intraradicular infection from the bacteria originating from coronal leakage,<sup>8</sup> we suggest that the 6 PS cases with swelling and 4 PS cases with fistulation in the study reported by Peñarrocha et al.<sup>9</sup> are probably caused by having reinfection from the above-mentioned bacterial sources. However, the findings of the aforementioned study and our study indicate that although the

majority of PS cases are often asymptomatic, uncommon symptoms and signs such as pain, swelling, and fistulation may still occur if the PS gets bacterial reinfection. However, it is still difficult to explain why there are no significant inflammatory cell infiltrates in those PS cases with pain, swelling, or fistulation in the study reported by Peñarrocha et al.,<sup>9</sup> because for a fibrous connective tissue specimen with a significant inflammatory cell infiltrate, the histopathological diagnosis should be a periapical granuloma rather than a PS.

In this study, amalgam particles presented as large black fragments and small discrete black granules were discovered microscopically in one PS specimen of a patient. This patient had a previous periapical surgery with retrograde amalgam filling. In addition, the periapical radiograph showed radiopaque particles in the periapical radiolucent lesion. Thus, the past dental history plus histologic and radiographic findings confirmed that the foreign body materials were



**Figure 2** Histopathological features of a periapical scar (PS) with embedded amalgam particles. (A and B) Medium-power microphotographs of a PS exhibiting aggregates of small and large black amalgam particles in the dense fibrous connective tissue. (C) Aggregates of small amalgam particles were surrounded by fibrous connective tissue with a more significantly mild chronic inflammatory cell infiltrate. (D) However, aggregates of large amalgam particles were surrounded by fibrous connective tissue with minimal chronic inflammation. (Hematoxylin and eosin stain; original magnification; A, 10 $\times$ ; B, 20 $\times$ ; C, 40 $\times$ ; D, 40 $\times$ ).

amalgam particles. Buchner<sup>12</sup> studied the amalgam tattoo of the oral mucosa and found that amalgam is present in the tissues in two forms: either as irregular, dark, and large metal fragments or as numerous, discrete, black, and fine granules dispersed along collagen bundles or around small blood vessels and nerves. In most amalgam tattoo lesions, the amalgam is presented in both forms. The biologic response to the amalgam is related to particle size, quantity and elemental composition of the amalgam. Large amalgam fragments often become surrounded by dense fibrous connective tissues with minimal inflammation. Fine amalgam granules are dispersed in dense fibrous connective tissues with a mild or moderate chronic inflammatory cell infiltrate.<sup>12</sup> The similar large and small amalgam particles were also observed in our PS specimen.

It is still not clear why some inflammatory periapical lesions heal with the regeneration of new alveolar bone but others repair with the formation of a fibrous scar tissue after an appropriate endodontic therapy. The regeneration of new alveolar bone in a jaw bone defect needs the undifferentiated mesenchymal stem cells and the induction factors (such as bone morphogenetic proteins) or requires the osteoblasts that migrate from the adjacent healthy periosteum or endosteum directly and some bone growth factors that stimulate osteoblasts to proliferate.<sup>13,14</sup> PS occurs most commonly when both the facial and lingual cortical plates have been lost.<sup>1</sup> In one (case 7) of our PS cases, fenestration of labial cortical plate at the periapical area was discovered during the periapical surgery (Table 1). Moreover, these findings suggest that the lack of the adjacent healthy periosteum or endosteum to provide the bone

forming cells (osteoblasts) may result in a defective healing with the formation of fibrous scar tissue. Nair stated that the PS originates from connective tissue-forming cells that colonize the periapical area before the cells responsible for generating the various structural components of the apical periodontium do so.<sup>8</sup> This statement emphasizes that the time factor is also pivotal in the tissue dynamics of periapical new bone regeneration. Other possible mechanisms leading to the formation of scar tissue during the healing of a periapical inflammatory lesion may include the production of too much type III collagen that is not replaced by type I collagen or deficiency of matrix metalloproteinases that are not enough to degrade the over-produced extracellular matrix during the remodeling phase of wound healing, and over-production of transforming growth factor- $\beta$  by the macrophages or over-production of collagenous proteins by the myofibroblasts in the wound tissue.<sup>15</sup> Further studies are needed to elucidate why there is a defective healing of the periapical inflammatory lesion with the formation of fibrous scar tissue after an appropriate endodontic therapy.

The PS is an alternative healing process of a periapical inflammatory lesion with the formation of a fibrous scar after an appropriate endodontic therapy. In general, there is no need to treat this kind of fibrous scar if the clinicians can recognize that the periapical lesion is merely a PS. Therefore, the difficult problem is how to differentiate the rare PS lesion from the more common periapical lesions such as periapical granuloma and radicular cyst. The common clinical and radiographic features of PSs would be: 1) the previous endodontic treatment/retreatment shows an

adequate root canal filling; 2) the previous periapical surgery is well performed with a proper retrograde filling; 3) the involved tooth is free from any symptom and sign; 4) the involved tooth has no evidence of root fracture and healthy periodontium except the periapical radiolucency; and 5) the well-defined periapical radiolucent lesion has persisted without a significant change of its size for a long period of time. Therefore, if the periapical radiolucent lesion possesses the above-mentioned common findings, it may be a PS lesion. Under this condition, a long-term follow-up of the involved tooth with the periapical lesion may be a more conservative treatment strategy. However, if the clinicians still have the suspicion of other possible lesions, then the removal of the periapical lesion for histopathological examination and final confirmation is another treatment of choice.

### Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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