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CLINICAL ARTICLES

Periapical Surgery of Mandibular Posterior Teeth: Anatomical and Surgical Considerations

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Periapical surgery is a well-accepted technique used to salvage endodontically involved teeth that cannot be satisfactorily treated or retreated by nonsurgical conventional endodontic procedures (1–4). Indications for periapical surgery are well described in the above mentioned endodontic references. Considering that the prognosis of success following endodontic surgery ranges from 60 to 89% (5–8), this procedure is a viable alternative to extraction or intentional replantation procedures of molar teeth not amenable to conventional root canal treatment (9, 10). However, it should be realized that, in comparison to conventional therapy, the success rate of surgical intervention is somewhat reduced (11). Caution should be exercised, specifically in periapical surgery of mandibular posterior teeth due to the potential damage of the mental and inferior alveolar neurovascular bundles (12). The purpose of this paper is to consider some important anatomical and surgical factors related to periapical surgery in this region.

ANATOMICAL CONSIDERATIONS

Mandibular Canal, Inferior Alveolar Nerve, and Artery

Radiographically, the mandibular canal is evidenced by a radiolucent band. The canal varies greatly in size and in its relationship to the roots of the posterior teeth (13). Often it closely proximates or may even come in contact with the roots of the third molar. Sometimes, it is in the proximity of the roots of all mandibular molars (Fig. 1). Anatomically, the mandibular canal is situated lingually to the roots of posterior teeth. The inferior alveolar nerve is the largest branch of the posterior division of the mandibular nerve. It runs vertically downward with the inferior alveolar artery from the infratemporal fossa, entering the mandibular foramen on the medial surface of the ramus of mandible. It courses through the mandibular canal in the body of the mandible and supplies all mandibular teeth and their supporting structures. The inferior alveolar artery, a branch of the maxillary artery, travels closely with the inferior alveolar nerve.

Mental Foramen, Nerve, and Artery

The mental foramen appears on radiograms as an oval or round radiolucent area in the mandibular premolar region. Its location varies in relationship to the roots of the premolars. Its image may be seen inferior to, at the same level as, or superior to the root apices (13). It also may be situated directly over the root of either premolar, or between them (Figs. 2 and 3). Sometimes, the communication between the mental foramen and the mandibular canal can be seen (Fig. 4). The mental foramen is not always visible radiographically. The mental nerve, a branch of the inferior alveolar nerve, emerges with the mental artery through the mental foramen to supply the oral mucosa and the skin of the lower lip and chin. The mental artery is a branch of the inferior alveolar artery.

Vestibular Fornix (Mucobuccal Fold)

The depth of vestibular fornix varies and is limited by bony ridges or prominences in the mandibular molar area (14). If the vestibule fornix is deep, the overlying buccal alveolar bone will be thin (Fig. 5*A*). If the vestibule fornix is shallow, the buccal alveolar bone, overlying the roots of mandibular posterior teeth, will be thick (Fig. 5*B*). In general, the premolars and first molar are close to the buccal alveolar plate, whereas the second and third molars are closer to the lingual plate (2).

SURGICAL CONSIDERATIONS

Mandibular Canal and Inferior Alveolar Neurovascular Bundles

To avoid injury to the mandibular canal and its neurovascular contents, it is essential to have undistorted diagnostic radiographs to show the accurate length of the involved teeth and its relation to the

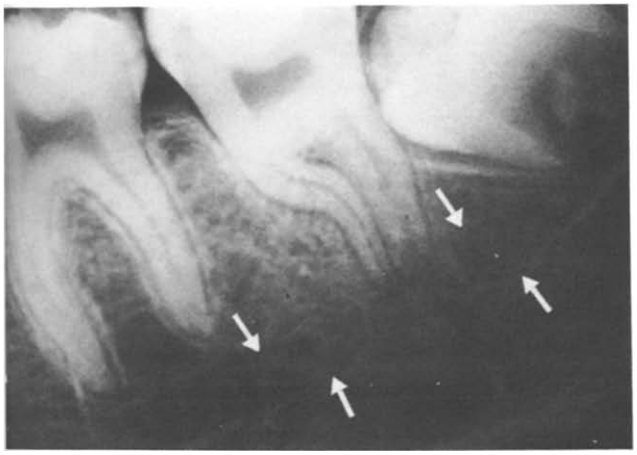

FIG 1. Mandibular canal (*arrows*) in proximity to the roots of mandibular molars.

FIG 2. Mental foramen (*arrows*) located at the apex of second premolar.

FIG 3. Mental foramen (*arrows*) situated in the periapical area between two premolars.

mandibular canal. In most cases, the paralleling technique of periapical radiography is quite suitable for this purpose in mandibular posterior teeth since the film can be easily placed close and parallel to the long axis of these teeth, thus preventing significant distortion of the radiograph. Panoramic radiography also can be used for this purpose. After the surgical flap has been retracted, a premeasured instrument should be placed along the buccal alveolar bone covering the involved tooth to determine the approximate location of the root apex. If no periapical radiolucency is observed and/or if the cortical bone is still intact, the entry of the surgical bur at the buccal alveolar bone should be kept at least 4 mm above the estimated apex. The cortical bone is carefully removed until the apical third of the involved root is located. The apex is reached by continuous removal of the cortical bone following the outline of the root apically. If the root apex cannot be accurately located, a sterilized radiopaque material such as a piece of gutta-percha or lead foil from the X-ray packet should be placed in the bone cavity. Radiographs are then taken to verify the work area in relationship to the root apex and the mandibular canal.

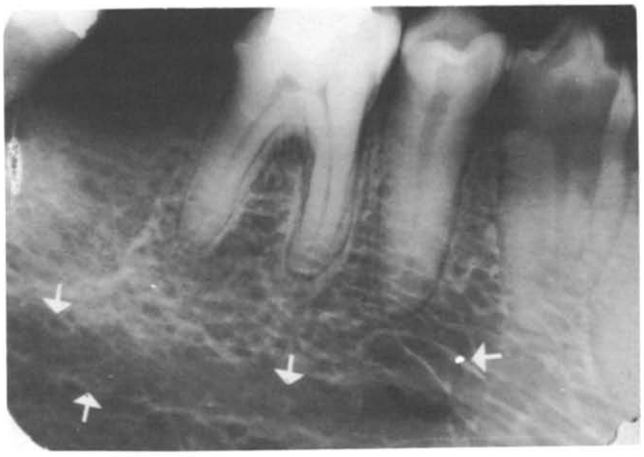

FIG 4. Note the communication between mental foramen and mandibular canal (*arrows*).

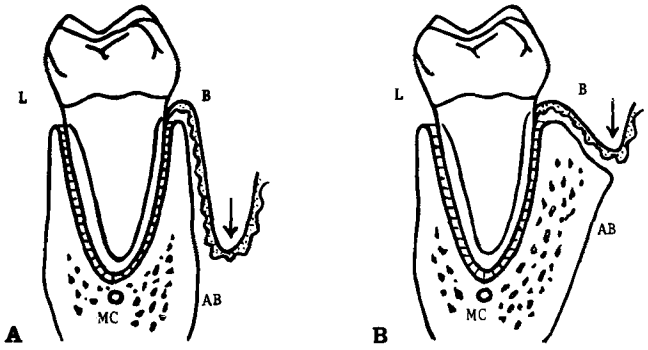

FIG 5. Drawings of mandibular molars and their supporting structures mesiodistally. *A*, Tooth with deep fornix of vestibule (*arrow*) and thin buccal alveolar bone plate. *B*, Tooth with shallow fornix of vestibule (*arrow*) and bulky buccal alveolar bone. *B*, buccal surface; *L*, lingual surface; *AB*, alveolar bone; *MC*, mandibular canal.

Mental Foramen, Nerve, and Artery

To prevent possible damage to the mental nerve and/or artery, a number of preoperative radiographs

is imperative. The radiographs should have distinct contrast and minimal distortion, thus permitting an accurate determination of the spatial relationship between the involved root apices and the mental foramen. This allows successful surgery in the foraminal area (Fig. 6). Usually, a deep vertical releasing incision into the periapical area between two premolars is precluded because anatomically the mental foramen is frequently situated in this region. It may sometimes be necessary to carefully expose the mental foramen and its neurovascular contents during the periapical surgery (Fig. 7). In this situation the patient may experience some temporary paresthesia due to traumatic injury of the mental nerve caused by retraction of the flap. Normally, it is not difficult to explore for the mental foramen and its neurovascular elements since the mucoperiosteal flap can be carefully reflected away from the underlying alveolar bone. When reflecting the flap in the mental foramen area, there is a resistance to retraction of the flap due to its attachment to the neurovascular bundle.

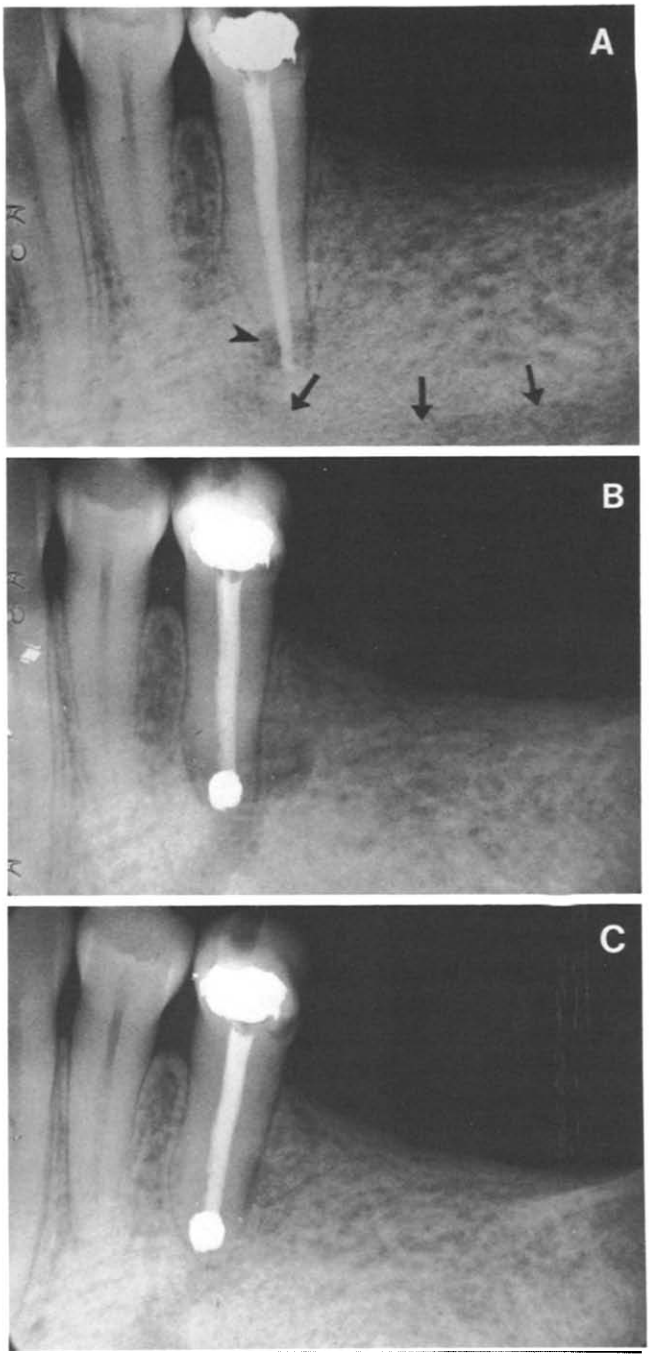

FIG 6. Mandibular second premolar. *A*, Preoperative radiograph. After completion of root canal treatment, the patient continued to have discomfort. Note the overfilled gutta point closely associated with the mental foramen (*arrowhead*) and also the communication between mental foramen and mandibular canal (*arrows*). *B*, Postoperative radiograph. During periapical surgery, the mental foramen and its neurovascular content were carefully exposed. The root apex was resected and retrograde amalgam placed. *C*, Follow-up radiograph. Six months after periapical surgery, the tooth was asymptomatic and there was sign of bony healing. The patient did not experience any symptoms of paresthesia.

Vestibular Fornix (Mucobuccal Fold)

To some degree, the depth of the vestibular fornix may forecast the amount of difficulty that may be encountered during periapical surgery of the mandibular posterior teeth. If the fornix of the vestibule is shallow, the accessibility to the periapical lesion will be limited. Therefore, the buccal cortical plate should be reduced before exploring for the periapical lesion (Figs. 8 and 9). Accessibility and visibility become less problematic when using a low-speed, straight handpiece. At the same time, it is easier for the operator to control the surgical procedure.

Flap designs in this area depend on the periodontal condition, the restorations present, and the location of mental foramen. The most frequently used flaps are the triangular and modified triangular full-thickness flaps. The former consists of one horizontal incision along the gingival sulcus in conjunction with a vertical releasing incision made on the interproximal bone. The latter is designed to be used specifically in the area where artificial crown is present. It is somewhat similar to the triangular flap except for the horizontal

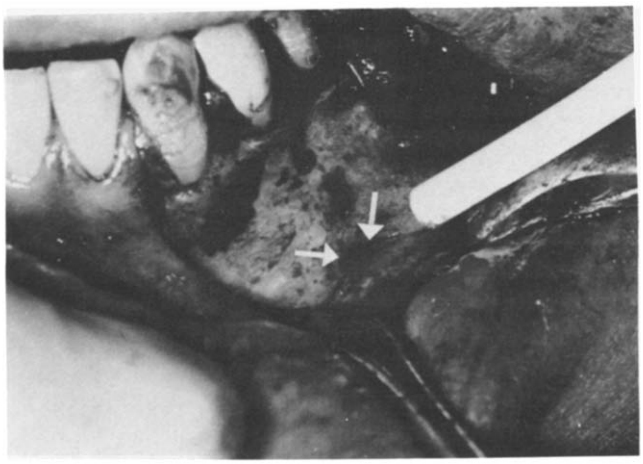

FIG 7. Mental foramen and its neurovascular content (*arrows*) carefully exposed during periapical surgery.

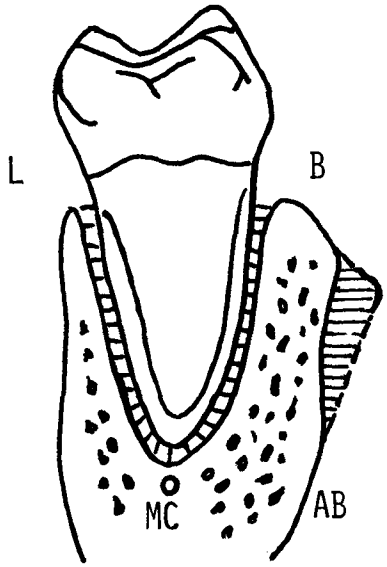

FIG 8. Drawing of mandibular molar and its supporting structures mesiodistally. Some of the alveolar bone (*horizontal lines*) should be reduced to overcome the accessibility to the periapical area during periapical surgery when the cortical plate is too thick. *L*, lingual surface; *B*, buccal surface; *MC*, mandibular canal; *AB*, alveolar bone.

incision made 2 to 3 mm from the depth of the gingival sulcus. During surgery the alveolar crest bone of the involved tooth should be conserved as much as possible to avoid periodontal complications (15).

Hemorrhage during periapical surgery may interfere with good visibility. The use of high concentrations of epinephrine to control the hemostasis should be carefully considered. The endogeneous catecholamine secreted into the blood stream by adrenal medulla due to the stress of surgery is added to the exogeneous epinephrine. The combined effect may complicate treatment of the medically compromised patient, causing a circulatory emergency. Thus, pressure application should be considered as an alternative.

When periapical surgery is performed on the mesial root of mandibular molars, the apex should be resected at least on a 45-degree angle to the occlusal surface. The apical preparation for the retrograde amalgam filling should include mesiobuccal, mesiolingual, and possible middle mesial canals in one slot preparation (Fig. 10) (12, 15, 16). Care must be taken not to perforate the root. To enhance accessibility and visibility for retrograde amalgam preparation, the beveling of the root apex in mandibular molars is sometimes performed slightly mesiodistally in addition to buccolingually (Fig. 11).

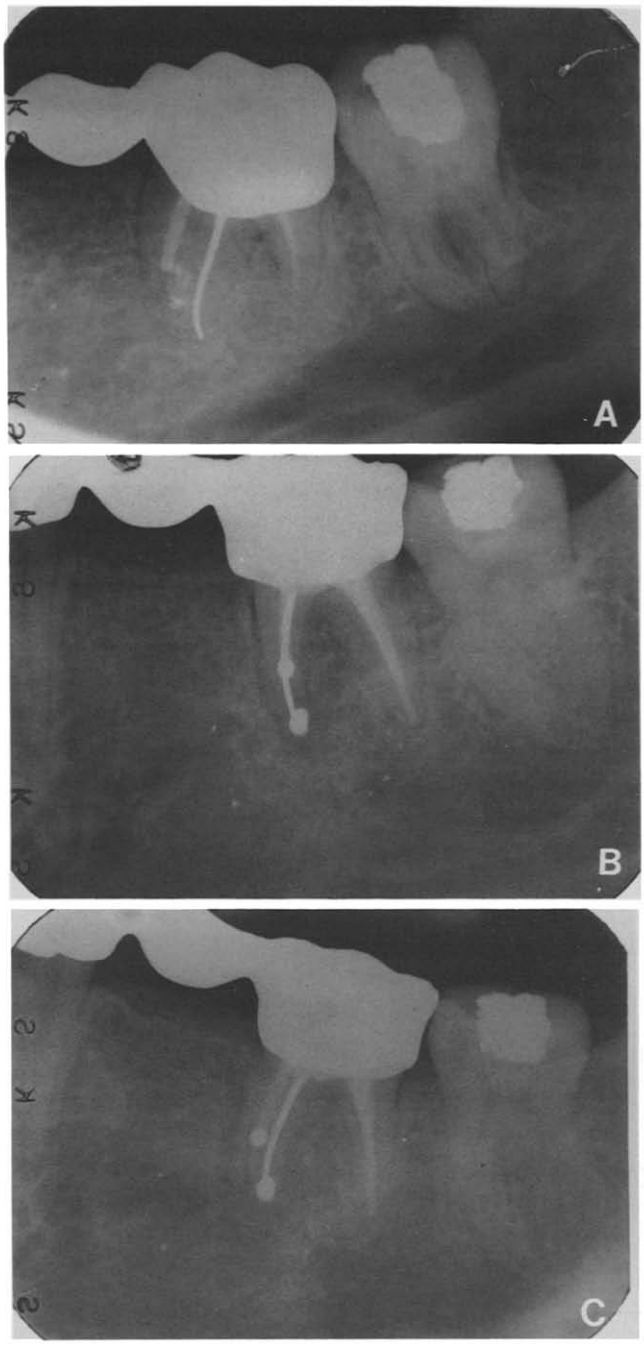

FIG 9. Mandibular first molar. *A*, Preoperative radiograph. Conventional root canal treatment failed and periapical surgery was subsequently performed without retrograde amalgam fillings about 7 months previously. Swelling and constant pain still present. Note the perforation of mesiobuccal canal. *B*, Postoperative radiograph. Mesiobuccal and distal canals were retreated conventionally followed by periapical surgery of the mesial root because the silver point in the mesiolingual canal could not be retrieved with all possible measures. Since the mandibular ridge overlying the roots of first molar was bulky, some of buccal alveolar bone had to be reduced to gain access to the periapical regions. *C*, Follow-up radiograph. One year after periapical surgery, the tooth was asymptomatic. There was evidence of bony healing.

DISCUSSION

Clinically, many studies have shown that conventional root canal treatment has a better prognosis than endodontic surgery (17–19). Histologically, persistence of inflammation in the periapical tissue after failure of endodontic surgery has also been demonstrated in the surgical specimens (11, 20–22). Thus, before considering the periapical surgery, all possible avenues of conventional endodontic solution to the

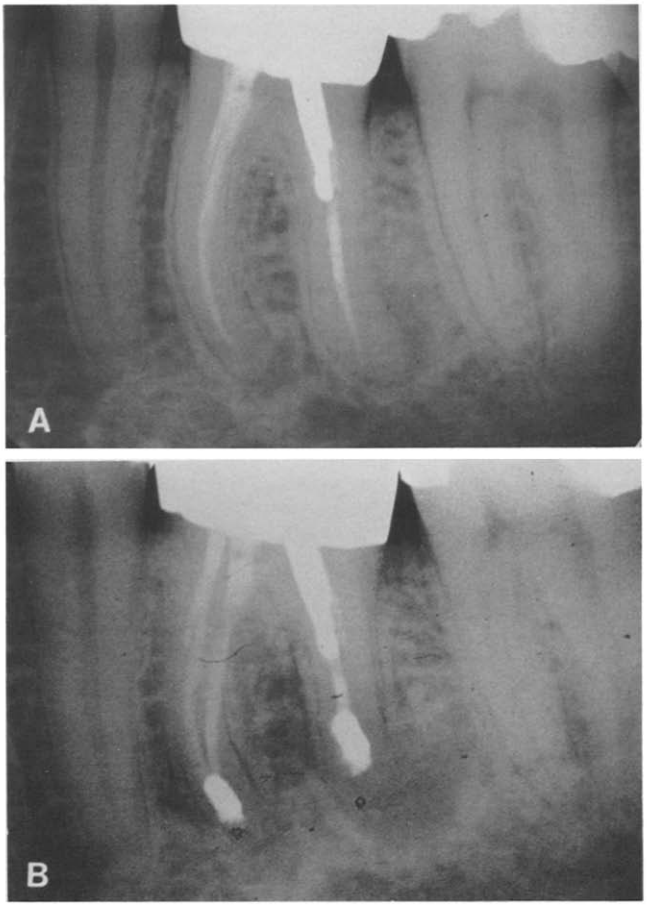

FIG 10. Mandibular first molar. *A*, Preoperative radiograph. Root canal treatment was performed 1 year before. The patient had a constant dull pain. There were periapical radiolucencies around the mesial and distal roots. Crown was constructed about 3 months previously. *B*, Postoperative radiograph. Note the retrograde amalgam fillings including the mesiobuccal and mesiolingual canals in the mesial root, and the distobuccal and distolingual canals in the distal root. The distolingual canal was not instrumented and filled during conventional root canal treatment.

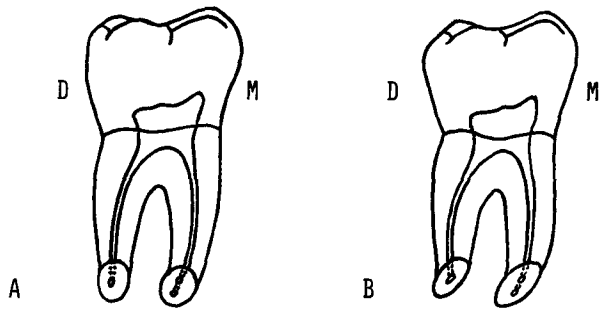

FIG 11. Drawings of mandibular molars mesiodistally. *A*, The root apices bevelled straight buccolingually. *B*, The root apices bevelled slightly mesiodistally in addition to buccolingually. *M*, mesial surface; *D*, distal surface.

problem should be completely ruled out.

It is very important to inform the patient fully about the potential of injury to the mental and inferior alveolar neurovascular elements before performing this type of periapical surgery. This is not only necessary for medical-legal reasons and patient management, but also to be in compliance with the doctrine of informed consent. Frequently, paresthesia is caused by carelessly placed incisions or inadequate bone surgery which injuries the nerve. When a sensory nerve fiber is cut or damaged, the distal stump simultaneously undergoes wallerian degeneration (23). Therefore, the patient will experience the bizarre symptoms of paresthesia. The regenerative process of the injured nerve fiber occurs from the central stump to the neuron. Full recovery of sensation may take from 3 to 9 months, depending on whether the mental or inferior alveolar nerve is injured and the severity of the injury (23, 24). However, permanent loss of sensation may occur if the mass of axon fails to reconstitute (23).

Case selection is an important factor to the periapical surgery of mandibular posterior teeth. When the patient has a very thick buccal alveolar bone plate, or if the mental foramen and the mandibular canal are in the very close proximity to the periapical lesion of the involved tooth, cooperation with an oral surgeon should be considered. From an endodontic point of view, the thickness of buccal alveolar bone can be an obstacle in attaining a good retrograde amalgam seal of involved root because of accessibility and visibility.

Retrograde amalgam filling should be placed on the roots of almost all teeth which require periapical surgery (25), because most failures of conventional root canal therapy are due to insufficient canal debridement and obturation (22). Despite the shortcoming of amalgam, e.g. marginal deficiency in vitro (26, 27), many clinical studies have demonstrated that amalgam is still the best retrograde filling material (28–30).

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