The Artificial Fistulation: A Monograph with Historical Views

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Abstract

Artificial fistulation is a treatment that has been carried out for centuries. Usually, only cases with indication and technical pre-scriptions are described in the literature. Problems in the follow up were considered minor. Long-term follow-ups with larger sample sizes are still hard to find.

Keywords: Root Canal Treatment; Root-End-Resection; Artificial Fistula; Trephination

Introduction

Artificial fistulation is the operative creation of an open connection, a canal, between vestibulum and periapex. The fistulation-action covers a bone-trepanation with or without periapical curettage. The procedure serves as pain therapy and is also used in pain prophylaxis.

A variety of termini can be found in the literature:

- Surgical fistulation

- Artificial fistulation

- Artificial sinus tract

- Trephination

- Apical trephination

- Cortical trephination

- Schröder lüftung.

In a broader sense, artificial fistulas provide measures to reduce enlarged periapical lesions.

These are targeted as:

- Decompression

- Marsupialization.

Furthermore, the artificial fistulation is thematized:

- One-visit endodontics

- Surgical endodontics

- Fistulative surgery

- Periapical curettage.

The multifaceted word creations point out that the process is not standardised, although it has been known for about 5000 years. A lower jaw from the 4th Dynasty (2900 - 2750 BC) with 2 artificial holes in the area of teeth 46, 45 was discovered in an Egyptian tomb. The drill-canal points to the tooth-tip of 46 at an angle of 15°. One borehole lies above the foramen mentale between roots 46 and 45, a further one slightly higher between the roots of 46. The boreholes have probably been drilled with a so-called "fire drill". X-rays show extensive rarefication in the mesial root of tooth 46. The sharply limited bores obviously provide a connection from apex to vestibulum to achieve a ventilation and drainage of the pain spot.

In 1728 Fauchard [1] stated that a tooth- trepanation or incision would not be sufficient in severe cases of pain. The causes, which are in the tooth, were to be treated. As a rule Fauchard preferred the extraction. Serre [2] treated the odontogenic sinusitis maxillaries by loosening a bone plate above the first molars to facilitate flow of fluids. None of the surgical interventions observed by Serre would, however, have had a recovering effect on their own.

Hullihen [3] practiced the "Hullihen surgery", named after him, for the first time in 1845. This operation consisted in making a hole through the gum, the outer edge of the alveolar process, and the root of the tooth into the nerve cavity, and then into opening the blood vessels of the nerve". The idea of this operation was to preserve the pulp. Alphonse Désirabode [4] described his procedure treating an inflamed root canal in 1857. After a vertical incision, he would release the root tip with a bone knife. Then he would penetrate the nerve at the entrance to the root.

Farrar [5] published his method of surgical ventilation to cure an apical inflammation in molars in 1880. He used a Palmer spiral drill inter-radically in the area of the attached gingiva. Regarding the lower second and third molars, he favoured lingual penetration. The direction of action of the instrument should always be directed diagonally from the puncture site towards apical rarefaction. In 1884 Farrar [6] spoke out in favour of a root-end- resection (RER) or root amputation as the better method in necrotic roots.

In 1886 Grayston [7] reported that in case of therapy-resistant endodontic treatments he had applied an artificial fistulation. He fistulated by drilling through the mucosa and bone.

In 1897 Rhein [8] recommended surgical interventions by using a mechanically operated drill in the vestibule at the height of the affected root tip.

Von Hippel [9] spoke in favour of a periapical curettage in 1914. After having removed the soft tissue, he applied the root-canal-filling (RCF), which he called, healing cement". His goal was to obtain overfilling. In a final step, he removed the excess filling material.

In 1924 Schröder [10] used the term "Lüftung" (= ventilation) in describing a surgical intervention in therapy-resistant gangrenous teeth. First, he filled the root canal with chloropercha, then penetrated the bone above the root tip with a rose-head bur. A proceeding incision is not mentioned in his publication.

Molnar [11] published in 1938 that he had successfully carried out more than 200 fistulations using a trephan drill. Following the local anaesthesia and prior to using the drill, he pulled up the mucous membrane in the vestibule and used his fingers to firmly press it onto the bone surface. The actual drilling process would only take 3 - 4 seconds. Apart from any swelling, there were no problems. Molnar emphasized; it would be unnecessary to reach the apex. It would be enough to attain the periapex. In multi-rooted teeth the author was convinced of the effectivity of penetrating the cortical bone inter-radicularly. In his 1939 publication Molnar [12] stated that he had done the apical trepanation in many cases prior to the RCF and, therefore, not in the same session. Furthermore, he mentioned that Schröder had been paying close attention to the fact that he, Schröder, had already recommended the Molnar method 30 years ago and had called it "Lüftung".

Walkhoff [13] stated that a granuloma treatment with the opening of the granuloma to the oral cavity via a natural or artificial fistula would be easier. If a natural fistula was not present, the author made an incision prior to the bone-penetration using blunt cannulae or "cannon drillers". Then the granuloma content was aspirated, followed by rinsing the root-canal, the lesion and the artificial fistula. What followed in the last step was an RCF with iodoform.

Castagnola [14] followed Walkhoff's suggestions. In cases of continuous secretion from the root canal he rinsed the root canal and fistula, natural or artificial, with Chlorophenol Camphor Menthol. To gain an artificial fistula Castagnola made a slit into the gum and a cortical piercing at the height of the root tip.

At an international dental congress in 1909 in Berlin, Roy [15] said that he had successfully been using the periapical curettage for 8 years for the following indications:

- Failure or therapy-resistant conservative gangrene treatment

- Fausse route

- Small radical cysts.

He had never seen a relapse. Roy had performed this method in all types of teeth except for the lower front teeth due to missing opportunities.

In 1925 Roy [16] described his procedure. In a first step he performed an RCF, deliberately causing a slight overfilling: Then an RCF was performed

- (Preferably) immediately prior to an apical curettage

- Immediately after the curettage

- 24 - 48 hours after curettage.

The actual ventilation was carried out with curettes or round drills. According to Roy, neither drainage nor sutures were necessary after trephination.

Furthermore, Roy saw several contradictions related to the curettage:

• Extensive bone necrosis

• Extended fenestration of the root

- Large cysts (extracting the tooth would be advisable).

"Ventilation" interventions have been described in the literature with and without incision.

Many authors used the ventilation both with and without previous incision.

Müller [17] referred to Roy when presenting his own fistulation method. Following an arch cut and cortical trepanation with a rose drill he performed his treatment in 2 sessions: first session canal-preparation, partial curettage, and insertion of a drain; 2 days later RCF with Walkhoff-paste and gutta-percha-point. Müller emphasized that these patients would have little or no pain, possibly had a slight swelling and tension. The X-ray examination would show a considerable lesion-reduction after 2 - 3 months and later a disappearance of the lesion and bone grafting.

Redtenbacher [18] incised up to the corticalis. Then he entered the apical region with a reamer of size 20/25. Next, he expanded the opening with a small, slow-running rose drill and drained if necessary. For aberrant patients the author relinquished an incision and assisted with a reamer perforation through the mucosa to the translucency.

Trauner [19] preferred bone penetration without incision. For the actual trephination he used the pointed end of a drill to pierce the gingiva and let it run for a second. Within half a year Trauner fistulated 64 times as a final treatment measure. Within these six months he had chosen fistulation as an introductory preliminary procedure 30 times, which was followed by RER in a later session. Trauner observed no complications following his fistulations. In a few cases the mucosa remained sensitive to pressure for some time.

At Sargenti, his publications and books are yet to see a change in his fistula treatment. In the years 1965 [20] and 1968 [21] he wrote that he applied an 1 cm long arch cut over the root tip, and for the bone-perforation Sargenti selected a slowly rotating cylinder drill ("spirec drill") with 1.5 mm diameter. The fistulation lasted 5 - 10 seconds. As alternative to drillers Sargenti [22] mentions round drills, bone cutters, turbine drillers, and instead of a mucosal incision he decided to take a sharp, raspatorium, which he pressed into the mucous membrane. The gingiva would be exerted.

The Sargenti-invention "fistulator" works in a similar way, and the gingiva can be exerted in the same way as the bone perforation. The fistulator is a hand-held spatula-like instrument, which has an eyelet with a 2 mm diameter at the bent function end. This end is fixed to the mucosa and drilled through the axial opening through the mucosa and cortical os towards the root tip. 1974 Sargenti introduced his "Fistulamates". In this tool fixation and drilling functions are combined. The contact pressure is applied via an integrated pressure spring. The drilling depth is limited to 6 mm.

Artificial fistula is a relatively rarely used procedure. An intervention without a previous incision is the traditional procedure. Today the practioneers use an incision. The description of the incision is versatile in the literature: different lengths, different distances to the root or tooth axis, vertical or horizontal, an arch cut or flap.

From the literature it is evident that the fistulative cortical trepanation is executed with hand instruments (stilettos, arrows, reamer, spreader, chisel, hand drill) or by machines (round drill, spiral drill, milling cutter). The machine-drills are different in size and construction. Sometimes a slow, sometimes a quick drill-rotation is recommended. Most authors believe that perforating the cortical bone is enough. Other authors prefer a perforation into the spongiosa. It is clearly agreed that the aim of the efforts is not the apex but the periapex.

The authors' involvement is inconsistent regarding periapical curettage; it is often not even mentioned. Luebke [23] did not agree to remove any periapical granulation tissue. The authors Lin., *et al.* [24] justified their view that a partial curettage would be enough. They said that the cause of the granuloma is embedded in the root canal, which must be treated. Morse [25] felt, that the removal of the peri-

apical granulation tissue would not be necessary for healing. However, he suspected that the healing would accelerate after removing the granuloma tissue, because the granulation tissue must be resorbed before the healing sets in.

Ørstavik [26] also thinks that the removal of the apical lesion has no influence on a lasting healing. After optimal root canal treatment (RCT), this problem would be solved alone. In other cases, Ørstavik only represents the following indications of a periapical curettage: therapy- resistant conservative treatment, removal of excess RCF- material, gain of biopsy material.

According to Frank., *et al.* [27] a bone-perforation near the apex is enough for pain relief. The authors see the periapical curettage as a more extensive procedure that either serves as a conclusive treatment measure or as an initial step to a subsequent RER. For the patients, the postoperative discomforts during trephination and periapical curettage was said to be equal (few).

In 1941 Jones [28] propagated the apical curettage for systematic gangrene treatment in one session in a non-acute case. In the case of emergency Jones started the endodontic treatment with incision and bone-perforation. Otherwise the root canal is prepared and filled right down to the apex. The endodontic measurements were finished by removing the granulation tissue and the RCF-overfilling. The total treatment took a maximum of 40 minutes. Jones considered this from the economic point of view: time saving for dentist and patient. Jones conceded the RER- indication only in cases of RCF that were filled insufficiently. In the 1950s, Jones [29] published a slight change to his treatment in severe cases. He introduced the RCT by curettage in order to look at the apex, to check if the RCF shows intentional filling-surplus.

Weaver [30] labelled his method as "open window curettage". Weaver summarized in this term the creation of a bone window over the root tip, removal of granulation tissue and excess RCF material as well as subsequent freezing of the root tip. In later years he started an RCT with a periapical curettage and subsequent RCF, which had to be overfilled. Weaver stated that he had treated hundreds of cases without failure.

Concerning extended periapical lesions, it is useful to utilize the fistulation- technique. This decompression-technique includes a short cut or flap, followed by a bone-penetration and a partial curettage or non-curettage. Followed by a drain insertion for days up to several months.

Freedland and Charlotte [31] create an Os window in the event of extensive rarefication. Then liquid and pus from the bone-cave are aspirated and saline solution is used for rinsing. In about a few weeks alternating drainage is incorporated. During this time, the RCF is performed. The authors considered whether healing could also have occurred with immediate RCF without rinsing and with shorter drainage time. In any case, as a benefit, the measures will reduce the size of lesions.

The authors Rud and Andreasen [32] speak in favour of a complete periapical curettage. As a benefit of periapical curettage, they value the full root length. This allows a better assessment of the healing progress. Furthermore, it has been proven that there is no difference between RER and periapical curettage when it comes to healing.

Some authors say, it is necessary to compare gangrene treatments with and without artificial fistula in relation to patients' subjective discomfort. Elliot and Holcomb [33] tested 40 symptomless front teeth and premolars with apical translucency in 2 sessions. Molars were excluded. In the first session, the canal-preparation was carried out. In the second session the RCF was performed. The 20 cases of artificial fistula had no afterpain. Of the 20 cases without artificial fistula, 5 suffered from stronger post-natal pain, so that in 3 cases an artificial fistula was retained.

Houck., *et al.* [34] tested the effect of artificial fistulae in 50 symptomatic gangrene teeth with apical translucency. After the RCF, 25 test teeth experienced an actual artificial fistula. In the other 25 cases a mock-fistulation was performed - that is only a perforation of the

mucosa. All patients received antibiotic protection as well as pain tablets along the way. Related to the subjective sensation of pain, there was no statistically significant difference.

A comparison test had been conducted by Moos., *et al* [35]. 17 patients with acute gangrene symptoms were subject to treatment. After complete canal-preparation all teeth were sealed with $Ca(OH)_2$. In 6 cases, supplemental fistulas had been performed. 4 hours after the treatment, the patients affected by the fistulation complained of more severe pain than the patients who had not been fistulated. After 96 hours, the difference in pain sensation was clearly resolved, so that no statistically significant difference was found.

Peters [36] conducted a comprehensive study in 225 gangrenous teeth, all of which were dealt with in a single session (root-canal-preparation and RCF) - including 125 cases, which were pre-treated another place. 12 of these 125 patients (= 9.6%) returned with pain. The fistulation was kept up. In one case the pain continued, so the fistula was repeated. Furthermore, Peters treated 100 another place cases not previously treated 50 times without fistulation and 50 times with immediate fistulation. In the fistulation-group no patient complained of severe pain. Of the 50 cases, which were not provided by an initial fistulation, 8 persons (16%) complained about pain. After fistulation, these patients were pain-free. The pain incidence of 9.6% and 16% respectively be clinical failure of fistulation. Peters considered the number of pains cases as low and thus he does not promote the artificial fistulation in gangrene treatment.

In 1955 [37] and 1962 [38] Cartin presented his method of RCT in conjunction with periapical curettage, which he performed in front teeth and premolars in 1 - 3 sessions under dry conditions: The RC-preparation was done with reamer and files, the root-canal-flushing with chlorine-solution and H_2O_2. The RCF was intended to be overfilled. For the following periapical curettage Cartin applied an incision above the root tip and provided the access through the bone towards the root tip by a special drill. Granulation tissue and excess-RCF-material are removed. Finally, the root tip is rounded off by a cylindrical diamond.

A pain medication is prescribed, and the patient is instructed to cool. For the entire treatment procedure Cartin gives a timeline of about 1 hour.

Vigier [39] reported on the observation of 200 fistulation-cases performed by a fistulator. A N2-RCF had been preceded the trephination. He noted no complication apart from a bleeding.

Southard and Rooney [40] treated 19 emergency gangrene cases with fluctuating swelling in a single session. First an optimal RCT was executed. Next, they incised in the area of swelling and inserted a drain. Then an additional artificial bone-perforation was omitted. Antibiotics were prescribed. In retrospect, the authors judged that antibiotics were not necessary. 24 hours after surgery, all patients experienced a significant reduction or complete disappearance of pain. After one year, 11 patients presented themselves for control. All were symptom-free. The apical lesions had diminished.

James [41] took the following advantages of trephination and periapical curettage from literature:

- The natural tooth length is obtained

- The cement cover of the dental tubuli is maintained

- The smaller bone-cavity is better for repair by osteogenesis.

James for his part sees the following indications of periapical curettage:

- Large periapical lesion, involving only a smaller part of the root (RCT has been anticipating the curettage)

- Extensive overfilling

- Failure of a conservative endodontic treatment.

The periapical curettage is accompanied by removal of necrotic root cement. According to James, wound healing and osteogenesis are like those in RER.

Sarkany [42] reported in her lecture that the clinic she worked for preferred the RCT to be performed in one session, either with RER or a final apical curettage. If dryness of the canal was not to achieve, RER or curettage were suggested as a first measure. In the year 1946, 35 patients were treated for a periapical curettage. 14 of these patients could have had a radiological check-up at least 6 months later. These cases appeared to have healed after 1 year. In a single case, a strong oedema occurred. In another case, the incision wound was not healed per primam.

Gutmann and Harrison [43] stated: "If definitive therapy requires surgery (RER etc.), there may be a temptation to substitute the definitive surgical procedure for the emergency trephination procedure." These surgeons ask if a surgical procedure is necessary but try the fistula first.

Telander [44] expressed "The one-sitting procedure in treating non-vital teeth with rarefication represents an interesting possibility without RER. In any case, in our office the use of artificial fistulation has completely supplanted root resection.

The full length of the root is maintained and the operation is well tolerated even by sensitive patients. Post-operative discomfort is insignificant.

Abou-Rass [45] feared the unwanted damage to a root. Therefore, he requires a flap for this operation. Weine [46] shares his concerns. He rejects the artificial fistulation as a routine treatment - especially without raising a flap.

Shovlin., *et al.* [47] refuse a fistula through the mucosa without incision, because of the danger injuring the affected tooth by the drill and an extensive scarring of the mucosa.

Ashkenaz [48] is opposed to the systematic use of artificial fistulation in gangrene teeth, but he recognizes the benefit of treatment in one session, saving time and money.

Follow-up studies on artificial fistulas are only rudimentary.

Berghagen [49] treated 68 gangrenous cases in one session, which he divided into 3 groups:

1. Group I: Conservative RCT- 24 patients - 7 of them later underwent a RER

2. Group II: RCT combined with curettage- 22 patients - 1 patient with RER more than 3 years later

3. Group III: RCT combined with RER- 22 patients.

In group II/III more swellings occurred. In group I patients complained about pressure pain. In terms of treatment results, according to the author, there was no difference between group II and III. The author considers the apical curettage to be a step forward over group III because of maintaining the root length.

Grung., *et al.* [50] diagnosed the success rate of periapical curettage and the RER one year postoperative. In this study, inaccurate and uncertain healing was summarized in the section "failure". The curettage (n = 76) showed 5.2% failures, the RER (n = 397) 13.3% failures.

In 1991 Molven., *et al.* [51] presented the results of a study that reviewed surgical interventions 1 - 8 years after failed conservative endodontic treatment. Following the orthograde revision root filling, 21 cases were completed with a periapical curettage and 111 cases were completed with a root tip resection. The authors reported two failure-cases (= 9.5%) following curettage and 4 cases (3.6%) following RER.

Two dissertations should be understood not as follow-up studies but as experience reports [52,53], which serve the N2- method related to Sargenti using fistulator and fistulamat. Both dissertations and various other publications confirm the statement of Ingle., *et al.* [54] in light of various studies, pain seems to be no more valid reason to avoid a single-treatment in endodontics.

Sargenti [21] saw the following benefits of apical ventilation:

- In most cases it can replace RER

- The patient-discomfort is significantly less than followed RER

- The time-consumption is considerably lower than after RER.

Sargenti [22] put together the indications for artificial fistulation:

- Beginning periodontitis, starting abscess: The ventilation eliminates the pain.

- Chronic secretion from the root canal: The canal becomes dry because the secret finds an exit through the artificial fistula.

- Treatment of gangrenous teeth in one session as a concluding measure after RCF. This one-session treatment saves time for patient and dentist. An acute exacerbation rarely occurs.

- Fistulation of overfilled vital teeth to avoid or treat pain.

- Via falsa with perforation of the root: A ventilation at the level of the via falsa alleviates the pain.

There are some studies [55-57] dealing with the use of artificial fistulas. A time measurement in front teeth and premolars was taken for the use of the fistulation interventions (n = 98). The average time needed was 3:30 min. Fistulation in the buccal roots of two upper molars took 5:45 minutes was needed. The average-fistulation-time for 8 lower molars was 6:20 minutes.

A study of the year 2019 [57] investigated the survival of 1308 RER and 762 trephinations (front- teeth and premolars). The median survival of both therapy forms with respect to the extractions was 30 years. Antibiotics had no statistically significant influence on survival.

Recently, endoscopic procedures support a periapical curettage/trephination. Engelke and Capobianco [58] speak of a minimally invasive technique using an "Odontoscope", where as a rule, the operation field is not accessible through open cutting guidance, but without flap through tunnelling soft tissues or the puncture of a body cave. After a short vertical incision, the odontoscope is inserted and a curettage can be performed in view. Thus, these authors say, that the odontoscope is not only a diagnostic tool, but also an assisted treatment procedure.

The authors Ozawa., *et al.* [59] report from their good experiences with the fiberscope unit. To diagnose and support the therapy under view, the 1 mm diameter fiberscope is inserted through a pre-existing fistula or over a 2 - 3 mm long incision. The authors mention the following advantages: the minimal cut length, the sight control, dispensation with stitches.

Conclusion

Overall, artificial fistulation presents itself as a quick and safe treatment method with a low complication rate. In many cases, the artificial fistula succeeds in replacing the RER. In the endo-surgical range of therapies, artificial fistulation should be given more attention.

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