

CHRONIC DENTAL INFECTION AS A CAUSE OF INEFFICIENCY IN THE ARMY.¹

BY MAJOR S. H. WOODS, O.B.E.

The Army Dental Corps.

THE subject covers a vast field and my demonstration and paper are planned as an outline of its main features.

It is essential that we should have a clear picture of what is implied by chronic dental infection in order to appreciate what effects on the health of the soldier and the officer may be directly caused, or profoundly influenced, thereby.

Two dental tissues are normally exposed to the mouth organisms: The enamel protecting the tissues within the tooth, and the gum margin protecting those surrounding the tooth.

What are these underlying structures?

Within the tooth: the dentine, enclosing the pulp. Surrounding the tooth: its periosteum—the periodontal membrane—and alveolar bone, surrounding the membrane. This membrane communicates with pulp at the apical foramen and with gum at the gum margin. Chronic dental infection originates in this membrane, which can be invaded along two paths, internal and external. The internal path, through the tooth, via the apical foramen; the external path, through the gum margin.

Each path gives rise to a separate type of focus of infection, which determines, to a great extent, the nature of the resultant systemic lesion.

THE INTERNAL PATH OF INFECTION.

When enamel breaks down as a result of caries, the underlying dentine is already deeply infected. If all the involved tissue is removed without exposing the pulp, the tooth may be restored without affecting its vitality. When the pulp is exposed during the operation, its removal is usually necessary before the tooth can be restored. There is much controversy regarding this procedure, which we will avoid by assuming that, in selected cases, it is possible to remove the pulp and seal the apex without affecting the sterility of the periapical tissues. This is the root-filled pulpless tooth to which we shall refer later. When caries has progressed until the pulp is directly involved, it dies, and infection passes along the root-canal and through the apical foramen into the membrane. Bacteriologists are generally agreed that the organisms which invade and multiply in the membrane are mainly the viridans group of non-hæmolytic streptococci, the predominating species being the *Streptococcus salivarius*. The truly hæmolytic group are very rarely found.

The invasion passes into the bone immediately in contact, and here we have the

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first type of focus of infection, known as periapical, involving an area of membrane and a volume of bone, both localized at the apex of the tooth—the so-called “dead” tooth. In the past, these teeth were treated by dressings impregnated with formalin compounds which were sealed for long periods in the cleaned-out root-canal, until the dressings were no longer foul-smelling, when the tooth and apical tissues were thought to be sterile. The root was sealed and the tooth restored by filling, inlay or crown, frequently to remain functional for many years without local sign or symptom of its infective condition until this was revealed by X-rays, which showed that the infection in both membrane and bone had persisted. It seems difficult to understand why this unsuspected condition could remain free from pain and inflammation. There are two possible explanations: (1) The absence of pus-forming organisms; and (2) the remarkably efficient lymphatic drainage of the membrane and the open texture of the bone, the products of the infection passing directly into the circulation. This direct absorption of toxic products from the periapical focus is known as closed infection, and is the most potent dental source of systemic disease. About 1910, a campaign was started against the retention of these dead teeth; it was interrupted by the Great War and subsequently resumed with great intensity, to become international on account of the general recognition of the serious effects of such retention on general health. This campaign has led to the development of new and very ingenious techniques designed to obtain sterility in and around the tooth. To show the complexity of the problem, it will be sufficient to mention that there are between two and three miles of minute tubes in the dentine, more or less impregnated with organisms and necrotic material. Bacteriologists are by no means satisfied that sterility is obtainable by these new techniques and we will assume that all dead teeth which have been restored are infective and therefore possible sources of systemic invasion.

We must note some changes in the affected tissues which have a practical bearing on our subject. In the membrane a rounded mass of tissue may appear near the apex—the granuloma—which is the first stage of the dental cyst. Granuloma and cyst are regarded as infective and so contributory to closed infection. On the root, new hard tissue of irregular shape may appear round the apex, making extraction an exceedingly difficult procedure. On the other hand, there may be a considerable absorption of the root, making extraction easy. All chronically infected teeth show either productive or absorptive changes at the apex.

There is a small, but very important, traumatic variety of closed infection. When the blood supply of the pulp is cut off, following injury to the apical vessels as a result of a concussion of the tooth, the pulp dies and a periapical infection supervenes. There is some doubt as to the path of the infection especially where enamel and gum margin appear intact. Many think it is by the blood, circulating streptococci finding a fertile soil in the membrane which is irritated by the products of the necrotic pulp. This variety is mainly confined to upper and lower incisors which are more exposed to injury than posterior teeth. It is characterized by a discoloration of the tooth. The remarks on the retention of dead teeth apply with even greater force to this variety because here the streptococci are frequently in pure culture and the truly hæmolytic group are sometimes found. Many cases of fatal infective endocarditis have been traced to such teeth.

THE EXTERNAL PATH OF INFECTION.

The junction of gum margin and enamel forms a watertight seal—the gingival trough—which shuts off the underlying membrane and bone from the saliva. Injury to the gum margin, not healing by resolution, produces a barrier of granulation tissue which may succeed in protecting the underlying structures from invasion by the mouth organisms. When this barrier is ineffective, a destructive inflammation follows which exposes the membrane to direct infection, and it begins to shrink, exposing the bone which then starts to disintegrate.

The loss of both tissues takes place more rapidly than the shrinkage of the gum, and a paradontal pocket is formed round the tooth. The subsequent rate of progression depends on the local resistance of the tissues, being rapid in some cases and very slow in others. In the former type—the suppurative—pus from the pocket is discharged into the mouth and swallowed. In the latter type—the dry—the discharge may be slight or negligible.

These are the two varieties of so-called pyorrhœa alveolaris.

We also have the second type of local infection, the paradontal, involving the whole area of the membrane and a volume of bone many times that of the root. This is not confined to one tooth, but involves many, if not all, of the teeth in the arch. The infection is not due to a particular organism. Cultures from pockets, membrane, and bone give a great variety of mouth organisms, but the streptococci are invariably present and predominate, especially deep in the tissues. As the products are mainly discharged into the mouth and swallowed, this type of focus is called open in contradistinction to the closed variety, which we have seen, but there is also a certain amount of direct absorption from the bone. It is estimated that, if all the teeth are affected by advanced paradontal disease, the actual absorptive area is 20 square inches.

ELIMINATION.

The elimination of closed and open infection entails the removal of the membrane and the sterilization of the bone. The membrane is removed by extracting the tooth, to which it is more firmly attached than to the bone. The removal must be complete and it entails radical treatment of the granuloma and cyst, and the extraction of the root to the very apex, whatever its shape. If this removal is not complete, the retained tissues remain infective and the condition is referred to as residual root infection. Following removal of the membrane, the infection in the bone is dispersed by the phagocytes and the region ultimately becomes sterile. If this blood activity fails, the infection persists and we then have residual bone infection. These residual bone infections are of much importance.

[Specimens were exhibited showing all the forms of chronic dental infection described.]

Investigation by Okell and Elliott at University College Hospital reveals that there is a transient streptococcal bacteræmia, lasting a few minutes, in a large percentage of cases immediately after extraction of chronically infected teeth. In all cases, the organisms were of morphology identical with mouth streptococci, and were non-hæmolytic. Their most unexpected finding was the presence of streptococci in the blood before extraction, in 12 out of 138 cases of open infection.

FACTORS CONTROLLING THE EFFECTS.

The systemic effects produced will mainly depend on "the inter-relations of five factors, which I will express in the form of an equation.

$$\frac{\begin{array}{c} \text{Attack} \\ \text{(Direction)} \quad \text{(Intensity)} \quad \text{(Extent)} \quad \text{(Duration)} \\ \text{Path of Infection} + \text{Virulence} + \text{Dosage} + \text{Time-factor} \end{array}}{\begin{array}{c} \text{Resistance} \\ \text{(Defence)} \end{array}} = \text{Disability}$$

Path of infection.—There are three main paths: (a) By direct invasion of adjacent tissues, such as the antrum, eye and skin of the face; (b) by direct lymphatic absorption, as in closed infection; (c) by alimentary absorption: as in open infection.

Virulence or intensity of attack: Chronic dental infection is practically synonymous with streptococcal infection of a low virulence. In closed infection, the lesion is usually small, but the virulence is regarded as being higher than in the open type, which is always an extensive lesion.

Dosage or extent of attack: This depends on the number of teeth involved and the type of infection, being usually small in the closed, but always large in the open variety. All types may be present in any one case.

Time-factor or duration of attack: The longer the toxin-dosage is kept up, the greater will be its chances of overcoming resistance and the more marked will be its ultimate effects.

Resistance, or the defence: Chronic dental infection may be present for long periods, but as long as the toxic products are neutralized by the body fluids and the organisms are ingested and destroyed by the phagocytes, a systemic lesion will not result. This explains those cases in which an obvious focus produces no apparent ill-health.

Any lowering of resistance by disease or other factor will adversely affect the balance and then the unneutralized toxins and the circulating organisms in excess of the defence may cause disability.

The periodontal membrane is an exceedingly thin tissue occupying the very narrow space between the tooth and the bone, yet it is the primary dental focus of systemic disease.

THE EFFECTS ON THE SOLDIER AND THE OFFICER.

Each class presents a different dental picture and the difference is of great significance:—

(1) *The soldier.*—About 30,000 men leave the Service annually, being replaced by recruits of an average age of 19, the majority of whom have had no previous dental treatment except the extraction of a painful tooth. These recruits are rendered dentally fit during the few weeks of their training and a large percentage of The Army Dental Corps is detailed for this purpose. Thereafter, as circumstances permit, the soldier is examined annually and he receives continuous treatment throughout his service by The Army Dental Corps officers, who, as far as their number permits, endeavour to maintain the highest dental standard of fitness. Maximum restoration is their aim, but pulp removal is mainly restricted to the single-rooted anterior tooth

in which a satisfactory result is most likely to be obtained. Carious dead teeth and traumatic dead teeth are invariably extracted, thus eliminating the possibility of closed periapical infection.

The soldier joins for a period of service varying from three to twenty-one years. Paradontal disease is seldom seen in those with less than fifteen years' service, after which its frequency tends to increase and it becomes more evident towards the end of the twenty-one year period, when the soldier is about 40.

The progress of the condition is noted during the intervals of treatment and the teeth are extracted before it has progressed to a stage likely to cause inefficiency, thus eliminating the second type of focus. As his dental condition is under continuous control, closed infection is practically non-existent and advanced paradontal disease very infrequent. Therefore, inefficiency directly attributable to chronic dental infection is rare in the soldier.

(2) *The officer*.—Under present conditions the officer joins the Service dentally fit, but, as there is no Army Dental Corps establishment provided for him, the treatment he may receive is a matter of chance and depends on the time, if any, which can be spared from the treatment of the troops. He therefore continues to receive treatment by civilian dental practitioners and his dental condition is not under control. He commonly presents closed and open infections, of which he may be totally unaware until their elimination is necessary in the treatment of some disability for which he has reported. As would be expected, disabilities directly attributable to, or influenced by, his dental condition are very common in the officer and he has presented us with the great majority of the specimens exhibited.

DISABILITIES WHICH MAY BE DIRECTLY CAUSED, OR PROFOUNDLY INFLUENCED, BY CHRONIC DENTAL INFECTION.

Some typical cases are arranged in groups as follows:—

The antrum (five cases) : The upper teeth from the third molar forwards to the first premolar, and sometimes the canine, are in direct relation to the antrum. Acute infections of these teeth commonly give rise to acute antritis and do not concern us, but chronic, unsuspected infections of these teeth are frequently associated with a chronic antritis which fails to respond to treatment until the affected tooth is extracted. Rhinologists are now aware of this definite connexion and refer all cases for dental investigation, particularly as regards periapical and residual root infections. Open paradontal conditions are seldom associated with antritis.

The eye (five cases) : Chronic infection of teeth as a source of many inflammatory conditions of the eye has been definitely established, and this is to be expected on account of the very close anatomical relationship between these tissues. Choroiditis and iridocyclitis are the commonest of these conditions, but a dental source should not be lost sight of in those infrequent lesions such as retrobulbar neuritis and ulceration of the cornea. Closed infection is the usual type, nearly always of upper teeth and on the same side as the eye involved.

Skin of the face : Three cases of lupus erythematosus are shown, all due to closed infection. The first dates back to 1924 and is of special interest because

during the six years of the lesion, the dental condition was never called in question by the various Army and civilian consultants who treated the patient. To-day it would be one of the first investigations.

Gastritis and allied conditions: We are not concerned here with those gastric conditions due to masticatory inefficiency, but only with those due to infection of the dental tissues. Six cases of advanced paradontal disease are shown, in which it was considered to be primarily responsible for the disability. As regards closed infection, it is not usually a direct cause of gastritis itself, but there is a growing opinion that it is closely associated with some forms of gastric and duodenal ulcer, providing a possible source of those bacterial emboli which, it is thought, lodge in the valves of the gastric vessels. The diagnosis of gastric or duodenal ulcer is so serious that we are justified in eliminating dental infection whenever present, and in rendering the masticating efficiency as high as possible by inserting dentures at the earliest moment after extraction. This is our routine procedure.

Rheumatism: A connexion between dental disease and rheumatism has been noted since ancient times, due to the natural cure of some conditions following the shedding of teeth loosened by advanced paradontal disease. A recently discovered Egyptian papyrus records that an ancient Pharaoh was told that he would not obtain relief in his back and his feet unless his teeth were extracted. Hippocrates, about 400 B.C., reported the apparent cure of a case of articular rheumatism after some diseased teeth had been extracted. From A.D. 1800 onwards the connexion was increasingly noted, but the type of infection was mainly open. The closed type came into prominence about 1924, when the dental focus was rediscovered after the War. A section of the medical profession seized on it as an explanation of those rheumatic affections which proved intractable and recommended extensive, almost indiscriminate, dental extraction. Much harm was done by these extremists as the effects in so many cases were disappointing, and the resultant reaction in doctor and patient tended to discredit the dental focus as a cause of general ill-health.

We have travelled far since those days, and co-operation between doctor and dental surgeon has now brought about an infinitely better attack on the problem of rheumatic affections.

My experience of osteo-arthritis in the Army is that it is not intimately connected with dental infections, and this agrees with the general trend of opinion. It may be wise to eliminate dental infection if it is extensive, but results comparable to those obtained in the other forms of rheumatism must not be expected by medical officer or patient. These cases commonly show by X-rays the particular changes in the dental tissues which are a result of the general disease.

Tachycardia: This is frequently of dental origin, and cases of chronic myocarditis have also been treated. Closed infection is almost exclusively responsible for these affections.

During a patient's recovery from an acute infection such as influenza, pleurisy, or pneumonia, it is not uncommon for a cardiac irregularity to supervene, due to some unsuspected focus taking advantage of the patient's lowered resistance. The removal of this focus brings about a normal heart and a quick return to health.

Debility or chronic toxæmia: Two cases due to closed infection are shown, the patients being young officers, aged 30 and 22 respectively.

CONCLUSION.

There is one most important matter to which I must refer, namely the estimation of the degree of causal relationship between the dental infection and the disability.

Each case requires most careful investigation. The type and extent of the dental infection is determined by a combination of three investigations: (a) clinical examination; (b) transillumination; (c) X-ray. The second of these, transillumination, is an extremely valuable and rapid aid in diagnosis, opaque areas being positive evidence of infection.

The dental officer, having determined the dental condition, must now obtain a picture of the nature and extent of the disability, and here the personal co-operation of the medical officer is of vital importance. Until he has obtained a clear picture of the nature of the disability the dental officer cannot make his assessment with any degree of certainty. My procedure in all cases is to see the medical officer, give him an idea of the dental condition and obtain from him a precise diagnosis, as far as this is possible, and also an outline of the proposed general treatment of the case. If I consider that the dental infection is likely to be a causative, or aggravating factor, its elimination is then planned as a definite part of the general treatment and the results are noted. Thorough investigation, personal co-operation and careful assessment are the essential factors in the successful attack on the dental focus.

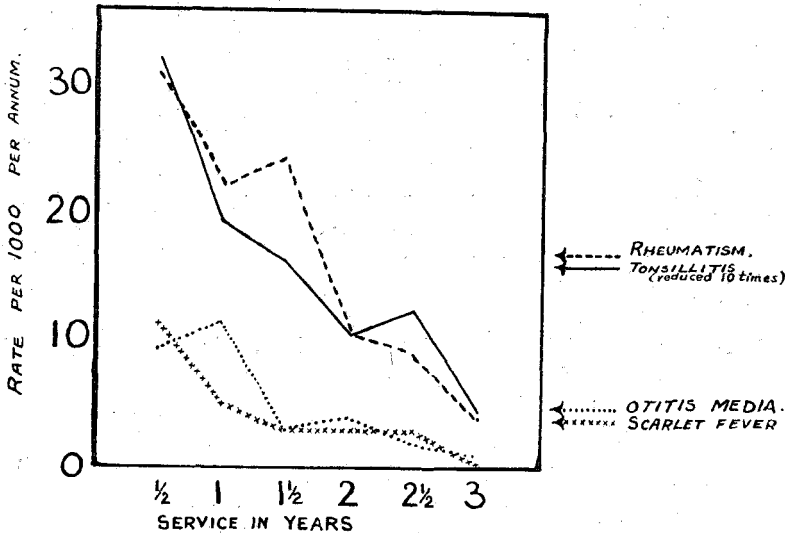
Discussion.—Surgeon Captain (D) E. E. FLETCHER, R.N., said that although similar types of cases were not infrequent in the Navy it was not thought that there was any undue predominance among the officers, but this was probably because they were entitled, equally with the men, to systematic dental attention from the date of entry and readily availed themselves of Service facilities. He would mention two cases of special interest: the first was one of long-standing arthritis of the cervical vertebrae which had shown marked improvement following the removal of previously unsuspected badly impacted and infected wisdom teeth, and the other of corneal ulceration which had resisted other forms of treatment, but had completely cleared up following the removal of teeth which, though clinically sound, on radiographic examination displayed a minor degree of closed sepsis.

Although Major Woods had stated that, in the Army, root treatment was restricted almost entirely to single-rooted teeth, it was presumed that in cases where the restoration of one or two devitalized multiple-rooted teeth would obviate the need for dentures, such root treatment would be undertaken and the risk of subsequent apical infection accepted. The age incidence of pyorrhœa was apparently less favourable in the Navy than in the Army: It was not uncommon in naval personnel to find persons much below the age of 40, with fairly advanced pyorrhœa, in spite of thorough treatment on entry and frequent re-examination. He thought that possibly the dry type of pyorrhœa, and its significance, often escaped observation.

Colonel JOHN HEATLY-SPENCER said he was glad that Major Woods made no claim for dental infection as a primary cause of osteoarthritis. There was, however, a group of fibrositic cases in young males in which infection played a definite part and in such cases many brilliant results had followed the cure of dental sepsis.

With regard to the general effects of the results of dental treatment in the Army, there had been a rise of about 12% in the number of completed dental treatments from 1930 to 1934, and one might expect this to be reflected in the figures for gastro-intestinal affections for this period. There was, in fact, a fall of about 18% in this disease-group for this period and the Dental Services might claim at least some of the credit. He could not accept dental sepsis as a primary cause of gastric or of duodenal ulcer.

Group Captain H. E. WHITTINGHAM, R.A.F.: Major Woods has dealt with chronic dental infection in the soldier and the officer, but has made no reference to its occurrence in the young recruit. That chronic dental infection occurs amongst the boys is definite, especially gingivitis and pyorrhœa. Researches in this connexion have been carried out in the Royal Air Force for the past six years at the School of Technical Training for Aircraft Apprentices, Halton, and an official report on the subject was submitted to the War Office three years ago in connexion with the Combined Services Sub-committee on the Prevalence of Tonsillitis and Allied Conditions. At the time, one had an opportunity of making observations also on the boys at the Army Technical School, Chepstow; these were of value for the purpose of comparison.



Incidence of tonsillitis and allied diseases among aircraft apprentices with special reference to length of service. Years 1927-1931. Average annual strength about 2,500. Arrows indicate levels of mean morbidity rates.

I propose, therefore, to give a résumé of statistics relating to dental infection in boys of the age-group, 14 to 18 years, and to discuss it under the following headings: (1) The dental condition on entry to the Service; (2) the dental condition after routine dental treatment; (3) the relation of gingivitis and pyorrhœa to tonsillitis; and (4) its relation to rheumatism and otitis media; (5) dental treatment.

(1) *The dental condition on entry to the Service.*—25% of the boys had gingivitis and 3% suffered from definite pyorrhœa at the early age of 15 to 16 years. This suggests that there is room for improvement in the dental hygiene as practised at home and at school.

(2) *The dental condition after routine dental treatment.*—Much has been done to correct irregularity and caries of teeth, also to remove tartar and lessen gingivitis, but the incidence of pyorrhœa remains practically as before.

From statistics produced, a comparison of the dental condition of the Army recruits and Air Force boys of approximately the same age-group, and living under similar conditions in a semi-closed community, showed dental defects to be more prevalent in the Army recruits than amongst the Air Force boys in the ratio of 2 to 1 for gingivitis, and statistics for a period of five years revealed that the Army boys had a morbidity-rate of tonsillitis three times greater than that of the Aircraft apprentices. These findings suggest that there is some correlation between dental sepsis and tonsillitis.



S. H. Woods

(3) *The relation of gingivitis and pyorrhœa to tonsillitis.*—The figures suggest that there may be some relation between inflammation of the gums and unhealthy tonsils, for only 14% of boys with normal tonsils had gingivitis, whereas 22% of boys with unhealthy tonsils had gingivitis. But, when the incidence of acute tonsillitis is investigated statistically, there is no evidence that gingivitis predisposes to tonsillitis.

Pyorrhœa, which, after all, is a more advanced stage of gingivitis, probably has some connexion with tonsillitis, as the tonsillitis incidence of 32% in this group is definitely greater than that of individuals with normal buccal cavities, in fact, it almost equals that of the enlarged-tonsil group, namely 33%.

Though the evidence that gingivitis predisposes to tonsillitis is inconclusive, it should be mentioned that individuals with gingivitis tend to harbour hæmolytic streptococci in their throats to a greater degree than those with normal buccal cavities or those with unhealthy tonsils, as an analysis of the flora of the tonsillar region of 100 boys, tested weekly over a period of three years, has shown.

(4) This leads to the question of the association of oral sepsis—gingivitis, pyorrhœa, and tonsillitis—with rheumatism and otitis media. Graphs show the similarity of curves of incidence of tonsillitis, rheumatism or otitis media, in fact, there appears to be a constant ratio between these diseases, acute tonsillitis being 10 and 30 times more frequent than acute rheumatism and otitis media respectively. The close association of these diseases is generally admitted, and together they cause a large amount of inefficiency. Their prevention is of prime importance, and it is possible that a greater degree of dental hygiene might lessen all these ailments.

(5) *Treatment* is chiefly a question of oral hygiene, and depends more on the individual concerned than on the dentist, though regular dental overhaul is a necessity. [The toothbrush, correct method of use, and tooth paste were mentioned.]