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PATHOLOGY OF THE TEMPOROMANDIBULAR JOINT AND ITS TREATMENT IN THE FIRST HALF OF THE 19TH CENTURY.

PART II

Curt Gerhard Lorber

Paper presented to the FDI Working Group on the
History of Dentistry, Amsterdam, 1989.

Hard-tissue surgery

In his surgical handbook of 1845, Johann Friedrich Dieffenbach discussed the treatment of true and false ankylosis. Despite sectioning the masseters or previous scarring, it was often completely impossible to depress the mandible by any method. As a last resort, in cases of true ankylosis, he recommended sectioning the ascending ramus after dividing both masseters. This difficult operation, which required great care, would be most likely to succeed by using an intra-oral approach, introducing a 1/2" chisel as high as possible posterior to the last molars, and dividing the ramus antero-posteriorly as close to the condyle as possible, with the aid of a wooden mallet. If this was successful on the one side, it was repeated on the other. The external approach, with a saw or the use of bone shears [by Liston], as in mandibular resection, would be more dangerous than the intra-oral approach with the chisel. With an external approach, separating the ascending ramus high up would carry the risk of damaging the facial nerve and causing an incurable facial paralysis. In sectioning the masseters, Dieffenbach followed Bonnet [whose cadaver experiments he cited repeatedly] in describing operative details. Although Dieffenbach's very vivid descriptions lead us to suppose that he had himself performed this operation, later remarks by his contemporary Verneuil refute this. In a medico-historical review of

1860) the latter declared that the preceding references were only theoretical and nobody had operated for ankylosis before then; such surgery for TMJ ankylosis was still in the realms of theoretical conjecture.

In 1846 J.L. Levison, a Brighton surgeon, described a specially-made leather chin-retractor, designed to prevent recurrent dislocation in a patient obviously able to reduce dislocation himself. This chin-retractor he declared to be far preferable to that of Joseph Fox.

Auguste Nélaton discussed the mechanism of dislocation in 1847. He agreed with Boyer who had earlier emphasized that luxation merely represented an arrest of normal physical movement of the condyle. After dislocation, this would remain anterior to the zygomatic process. Contact of the inferior angle of the cheek-bone with the tip of the coronoid process would therefore be a prerequisite for this luxation, as had been stated in a very old but subsequently refuted theory [Hunauld, 1726]. A case in the St. Antoine Hospital had given him the chance to test his new viewpoint, since simple finger-pressure intra-orally had produced spontaneous resolution, contrary to his expectation. Some time later he had been called to a patient with bilateral dislocations, which four other physicians had tried to reduce. He made the patient, who was seated in front of him, open as widely as possible, and, with his thumbs, pressed on her coronoid processes, applying simple pressure backwards, by which the condyles re-entered their sockets again. Compared with older methods, Nélaton regarded repositioning by pushing back the coronoid processes with the thumbs either side intra-orally [or even extra-orally immediately below the cheek-bone, supporting the fingers in the mastoid region] as successful. An observation

by Delacour served to support this theory. In Nélaton's opinion, the whole secret of repositioning lay in relaxing the muscles by asking the patient to open their mouth, and then gently pressing on the coronoid processes in order to push them backwards and a little downwards.

Jean Francis Malgaigne assumed that luxation was sometimes due to rupture of the ligaments and in other instances to their slackening. Bilateral dislocation should then be more frequent than unilateral. Giraldès had seen 13 unilateral dislocations in a total of 28. He himself had seen 54 bilateral out of 76; of these 54, 31 were in women. Of 40 cases, 25 were of muscular origin, i.e. 15 by yawning, 5 by convulsions, 4 by vomiting and one in a fit of rage; of the remaining 15 arising from external forces, 7 arose from introducing large objects into the mouth, 6 by drawing teeth, one by forcibly separating the jaws of a madman with much effort, and one by a kick from a horse. After exhaustive clinical descriptions, he rejected Petit's hypothesis that, after displacement, the condyles would pass over the centre of the insertion of the masseters on the zygomatic arch, so that the backwardly-displaced muscles would then hold the angle of the mandible posteriorly, and superiorly would then act as depressors. Petit had at first accepted that luxations could be of differing degrees, i.e. complete and incomplete. Malgaigne had no objection to the hypothesis of subluxation below the fibro-cartilage [disc], but nevertheless asserted that the anatomy would prevent differing degrees of luxation. He then dealt with all the 2 possible methods of repositioning in approximately chronological order.

Jules Guérin [*vide* Part I] reported a false ankylosis caused by a gangrene in the mouth after typhoid fever [1848]. He had applied a technique of his own called "par

displacement des cicatrices". Initially, in 1842, he had divided scar formation on the anterior border of the masseter. In 1844, renewed divisions of bands of scar tissue were necessary, with the subsequent use of a cheek-dilator with a gear-wheel. As a result of this, there was a local inflammatory response, which necessitated further division six months later. He then isolated the bands of scar tissue and surrounded them with a tube of platinum sheeting. After suturing with a silk ligature, he divided it about a month later and treated the soft granulation tissue on the exposed surface of the cheek with silver caustic. At a further review on 10 Aug. 1845, the slightly-built patient could open her mouth normally, i.e. more than 3cm, with acceptable masticatory movements.

Willem Vrolik of Amsterdam published an illustrated atlas in 1849 on embryology, mentioning an incompletely formed mandible, which was short and backwardly-placed. The wings of the sphenoid bone were so widened and the temporal bone displaced so far backwards, that the condylar fossae and the jaw itself appeared to have been forced towards the back of the head. The lower jaw was also too short in relation to the upper. The upper jaw and base of the skull were also grossly misshapen, with the central part of the zygomatic arch directed upwards. The alveolar processes were very short, with only four posterior teeth, and the upper incisors directly protruding. All these abnormalities were not evident at birth, but most probably developed with increasing age and the repeated movements of the lower jaw. All the peculiarities of this skull resulted from a common cause - the congenital hypoplasia of the mandible. Before the birth of this child, his mother had previously given birth to a misshapen hybrid.

Two unusual case reports

Dr. Wernher, director of the academic hospital at Geissen, also studied ankylosis [1850], observing that true ankylosis of the lower jaw occurred in only a very small number of cases, with even fewer successful attempts to treat them. He then described a 23-year old lady from Geissen, who had had scarlet fever at the age of 3 and been treated with plentiful doses of calomel; this had caused excess salivation, which Wernher considered to be the reason for the fusion of the jaws. The patient could move her lips, but was unable to separate her teeth. Astonishingly, [two] apparently bony bridges had united the jaws, arising from the first molars; the right bridge was 4" broad, and that on the left even broader. [Editorial note: These bridges would have been accretions of calculus.] The temporalis and masseter muscles were still mobile. On both sides the mucosa of the cheek was firmly united with the gum up to the anterior border of the bony bridge. The cheek and lip were detached surgically from the gum by a Dechaussair, and a 2.5" piece then cut out from the middle of each bony bridge with a fine saw. On the right, the presence of solitary teeth within the bony bridge created some difficulties. Using a Robbins lever, the anterior inter alveolar clearance was [forcibly] increased more than 0.5", after which the patient could close her mouth fully, proving that the TMJs had not lost their function entirely, despite 20 years' inactivity. Using physical therapy and daily application of the lever, the patient was able to open her mouth to 0.75" after several weeks.

Wernher concluded that bony union of the lower jaw with the upper could develop at three sites; either the top of the joint would be fused with its socket, or the coronoid process to the zygomatic arch by a bony bridge, or, finally, union occur between upper and lower alveolar processes. He refuted the opinions expressed by Cruveilhier and

Lacroix that TMJ ankylosis had to be bilateral. Of 15 cases cited in the literature, 7 were unilaterally ankylosed, with the other joint entirely free. Furthermore, in four observations of inter-alveolar union, the joints remained free in three. Similarly, the joints were free in one of two reports of fusion at the coronoid process. In complete immobility there is little to prevent ankylosis. Bony union of the alveoli, as described by Wernher, must have developed before the second dentition had completely erupted, since teeth had grown into the bony bridges, and the division of the latter necessitated the extraction of two very loose teeth. Hyrtl, too, felt that despite unilateral ankylosis from mechanical cause, the opposite TMJ would not lose its mobility, so that it would not be difficult to establish an artificial joint by an easily performed resection of the neck of the condyle. Until then the practicability of this proposal had not been tested.

* Augustin Schmitt, who had graduated from Geissen University in 1847 as doctor of medicine, surgery and obstetrics, but then worked as a dentist in Vienna, published a textbook in 1850 which included diseases of the mouth and teeth, and their treatment. This included a case of a wood-chopper's wife aged 49, from Vienna, who suffered from osteo-arthritis and facial pain, together with otalgia and erysipeloid inflammations. A swelling of the right side of the face and head appeared, which decreased after the application of suitable remedies, but left a hardening in the region of the cheek, which prevented her from opening her jaws that winter. On 19 March 1842, with the patient sitting in an arm-chair, a Dieffenbach tendon-knife was inserted into the posterior border of the ascending ramus, 1" above the angle [of the mandible]. The knife was then led away under the skin over the masseter and this cut through inwardly and parallel to the occlusal surfaces of the molars. The soft tissues were then pressed firmly against the bone

to prevent blood from collecting. The fibres of the masseters were partially tendinous and rustled during separation with the knife. This attempt to open the mouth was unsuccessful, so the left masseter was cut similarly. These muscle fibres were soft. With both sides divided, leverage was again applied, but despite some force there was hardly any perceptible movement; any extension effected put tension on the zygomatic arch. Using a long-handled, sickle-shaped knife, Schmitt made an intra-oral incision, between the cheek on the alveolar border and the masseter, leading the blade straight upwards to the tuberosity, then antero-posteriorly between the lateral pterygoid muscle and the temporalis as far as the tendon, which was then divided. The mouth could then be opened over 3 lines [0.25"], but only by using leverage. The cut through the masticatory muscles caused them to bunch up into knots, that on the right being greater and harder than that on the left and deforming the face considerably. Four days later, the patient could open her mouth to 1" without exertion or pain, and neither cheek [particularly the left] was swollen or tender to pressure. Two months after the operation, the right cheek that had previously been larger was now equal to the left, mastication and opening were in a healthy condition.

When Schmitt saw the woman again several years later, she assured him that she had not had any further difficulty in mastication. Professor Dieffenbach was especially interested in this case because of the union of the gum with the cheeks. When Schmitt reported the patient's good recovery to him, he was pleasantly surprised. Sectioning the masseter and the tendon of the temporalis had not been previously known before Schmitt's attempt. Bonnet later demonstrated this on cadavers, but neither he nor Dieffenbach had undertaken it on a living person.

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THE BIRTH OF THE SPECIALITY OF ORTHODONTICS

PART II

J.T. COOK

The second half of the 19th century is the period in which orthodontics really began to emerge as an organised branch of dentistry. Norman Kingsley, addressing the Alumni of the Angle School of Orthodontia in 1908 said that 50 years previously there were no orthodontics and no orthodontists. Dentists at that time were simply straightening teeth and making them even.¹ He could speak with authority because he published his first paper in 1858 and on that occasion, ended rather apologetically,

"Begging your pardon for occupying so much space in this, our first communication to any dental journal."²

Events proved that Kingsley had little need to be so modest; he has since become known as the father of orthodontics, but it seems probable that he was the product of changing attitudes to dental education that had its roots in earlier events - possibly the activities of Harris and Hayden in 1839.

Kingsley was one of a small group of men who entered the dental profession about that time and whose activities were to have far-reaching effects on the future of orthodontics. He was an artist and sculptor of considerable talent; his observation of large variety of normal arch form led him to conclude that, "symmetry and harmony do not imply uniformity."³ In other words, he realised that a wide variety of regular occlusions were

to be regarded as normal. He introduced a wide range of appliances, usually made from vulcanite, employing jack screws, ligatures and elastics to move the teeth. Kingsley stressed the importance of retention. He also used occipital anchorage and coined the term, "jumping the bite". He used bite planes in the upper arch to free the lower jaw and combined them with occipital traction on the upper jaw. He believed that this allowed the lower jaw to come forward into correct occlusion, but it seems probable that he was in fact retracting the whole upper dental arch. The principle of the bite plane and forward movement of the mandible however was subsequently incorporated in the appliances of Robin and Andrews.

In his book published in 1879, "Treatise on Oral Deformities as a Branch of Mechanical Surgery", he included not only the results of his own labours over the previous 20 years, but also a comprehensive summary of the work of those who had preceded him. The work included chapters on irregularities, aetiology, diagnostics and treatment. *

Another man who profoundly influenced orthodontic thinking was John Nutting Farrar. A contemporary of Kingsley, he recalled that his first regulating operation was performed on one of his own upper central incisors when he was a small boy. His outstanding tooth was moved into line by pressing his finger upon it several times a day for several weeks.

Farrar appreciated the need to consider the physiological processes involved in tooth movement in order to prevent pain, stating that the force used must be controlled; to achieve this he advised the use of intermittent force by means of a screw. His investigations formed the basis of his graduate thesis at Jefferson Medical College in

1874, and were later published in Dental Cosmos.¹ He advised intermittent movement of between 1/240 and 1/160 of an inch every twelve hours and he introduced a system of tooth movement based on jack screws, the first of many orthodontic systems. His book, published in two volumes in 1888, "A Treatise on the Irregularities of the Teeth"⁴ had over 1400 illustrations all drawn by the author and this had been regarded by many dental historians as the greatest work ever published on orthodontics. Farrar was exceptionally talented as a mechanic but he did on occasions seem to be carried away by his enthusiasm and it is difficult to believe that some of his appliances were wearable.

In 1881 W.H. Coffin reintroduced the spring plate originally described by his father, Walter, four years previously. * This was a vulcanite expansion plate activated by a spring made of piano wire, usually coated with tin to prevent oral fluids corroding the wire and loosening its attachment to the vulcanite. There are some fine examples of these appliances in the B.D.A. Museum.

Another man of influence was E. S. Talbot. He was particularly concerned with aetiology and the necessity of understanding this, since, "to know the cause is half the treatment".⁵ In 1888 he considered aetiology under several sub-headings, arrest of the development of superior maxilla; consanguinity in its relation to deformities in general; scrofula; drunkenness in parents; prenatal influences and intrauterine education; report of cases of arrested development and excessive growth of all the tissues in connection with idiocy; imbecile and feeble-minded children; abnormally shaped heads. * Many reviewers dismissed Talbot's contribution because of his approach to aetiology; he did make other contributions, including the introduction of surgical orthodontics, later revived as

alveolotomy. He removed portions of alveolar bone to facilitate tooth movement. He is also credited with the introduction of the coil spring.

Victor Hugo Jackson was a technical rather than a philosophical orthodontist and his book, "Orthodontics and Orthopedia of the Face" had only a few pages devoted to the theory of malocclusion, the majority concentrated mainly on removable appliances.¹⁰ He produced a modification of the crib, first mentioned by Delabarre and Schange, which greatly improved the retention of removable vulcanite appliances. His own skill, however, enabled him to obtain results that were beyond many dentists and his system never really caught on. He used the chin strap with elastic traction to an appliance on the upper teeth to treat cases of reversed molar bite, a technique revived in the 1950's.

Calvin Case was the most prolific author at this time and in 1908 his views were collected in his book, "A Practical Treatise on the Technics and Principles of Dental Orthopedia".¹¹ He pointed out that moving teeth into improved occlusion often left them tilted unsatisfactorily. He aimed to produced bodily movement of the teeth in order that the surrounding bone could be remoulded and that the facial contour could be improved. His appliance is often described as the first root moving appliance but Farrar had shown an appliance for this purpose some years previously. Case used intermaxillary elastics to treat cases of Class III malocclusion. H.A. Baker used elastics for correction of Class II Division 1 malocclusions and Angle subsequently credited Baker with the development of intermaxillary force and it became known as Baker anchorage.¹² It does seem however that Case was the first to us this.

The last of the men in this group was Edward Hartley Angle. He is probably known to most dentists as the author of the classification of dental arch relationships that is widely used in many fields of dentistry. This, produced in 1899, was the 26th classification published since the first by Fox in 1803.¹³ Among orthodontists Angle is remembered because of his invention of the expansion arch, the pin and tube appliance, the ribbon arch, and finally in 1925, the edgewise arch. The brackets that he invented are still in use, with only minor modification, in the most widely used orthodontic techniques today. However, I believe that his greatest contribution to orthodontics was in the field of postgraduate education and it is this aspect of his career that I should like to discuss.

Among the principles that had been established at the time he graduated were methods of tooth movement, including root movement utilising fixed and removable appliances incorporating springs, screws and elastic forces. Teeth were being moved individually and in groups. The concept of anchorage, including extra oral anchorage and intermaxillary traction were understood and the need for retention after tooth movement was recognised.

Reduction of crowding by extraction and by arch expansion was practised, the difference between continuous and intermittent forces and the need to control the force applied and the rate of tooth movement had all been realised. The importance of soft tissue pressure on dental arch form was recognised. Surgical shortening of the protrusive mandible, alveolotomy and rapid expansion of the maxillary suture had been advocated and practised. The principle of functional appliances had been applied if not stated. Given the limitations of the materials and diagnostic methods available, a good working basis

for successful orthodontic practice had been laid down; yet orthodontic treatment was not being widely and successfully practised.

With hindsight it is easy to pick out from the mass of literature those papers which time has shown to be valid, but these papers had appeared in a wide range of books, journals and pamphlets over a period of more than 150 years and for every worthwhile contribution there were scores of articles which were not. The chances of anyone finding his way without guidance through this morass, and emerging with any clear concept of the developing pattern were remote.

Many dentists at this time acquired their training as apprentices and it is unlikely that they were required to do a significant amount of reading, even assuming that they had access to the proper texts. Even those who attended dental college and acquired degrees were not a great deal better off. Dentistry at that time was struggling to achieve the status and dignity of a profession and although there were some dedicated teachers of great integrity there was also a welter of chicanery and sophistry. William Gies carried out a survey for the Carnegie Foundation and reported that between 1881 and 1899, 37 new dental schools were formed; many freely sold the degree of D.D.S. at home and abroad to the disgrace of dentistry and the dishonour of dental education.

Diploma mills were turning out fraudulent degrees in 1880 with Philadelphia as the centre of the racket.¹⁵ In 1889 the dental profession investigated the sale of fraudulent diplomas and found that the Cosmopolitan Medical College in Chicago sold more than 1,000 degrees in a year, inscribed to suit the wishes of the buyer, at prices ranging from

50 to 500 dollars. Even in the good dental schools the standard of admission was no higher than required for admission to high school and students were not required to buy their own books. It is scarcely surprising that few dentists had any understanding of orthodontics beyond that of a few gadget-minded practitioners who treated dental irregularities on an ad hoc basis.

Angle graduated from Pennsylvania College of Dental Surgery in 1876. In 1886 he was invited to join the faculty of the Dental School in Minnesota and the following year he was invited to give a paper in the section on Dental Irregularities at the International Medical Congress in Washington.¹⁵ Some ten papers were read on this occasion but the discussion degenerated into a bitter clash on priorities of discovery of the various methods and appliances that had been presented. The last speaker, Dr. Storey, concluded by asking whether the object of this section was to establish principles of guidance in the practice of the profession or to establish the precedence of better inventions. He said that, "instead of wrangling over priority, each of the claimants should have said - gentlemen, here is my discovery, you are welcome to it".¹⁶ The bitterness and animosity engendered at that meeting was never forgotten or forgiven by some of the participants and, even on his death bed, one of the speakers refused to be reconciled with one of his opponents.

Angle subsequently joined the staff of North Western in Chicago as a teacher of orthodontics but was dissatisfied with the facilities available for teaching the subject to dental students. Students were not required to purchase their own books or their own instruments and Angle insisted that they must have both. This was vetoed and Angle

resigned and moved to Pennsylvania Dental College. Again he was dissatisfied with the teaching facilities and moved to Marion Sims Dental College in St. Louis. Here orthodontics was part of the prosthetics department because of the mechanical approach to both subjects at that time, and once again he found that insufficient time was being allowed to teaching orthodontics.

He was now convinced that he could not impress the management of the dental departments of existing colleges to form special departments devoted to orthodontics and he concluded that it was impossible to teach orthodontics to undergraduate students. He stated,

"I became filled with the belief that if orthodontics was to make any material progress, a separate school, entirely independent of dental schools must be formed which would amply provide opportunity for those with aptitude and liking for the subject to study in a broad full and comprehensive manner."¹⁷

In 1899 Angle attended a meeting of the National Dental Association at Niagara Falls to describe his latest work and was approached at the meeting by four dentists who tried to persuade him to give them instruction and to start a private school. He took them into his office for three weeks and this was the beginning of postgraduate instruction in orthodontics. In 1900 he placed an advertisement in the dental journals indicating that he was prepared to teach a postgraduate course in orthodontics. This was immediately over subscribed and the first class of the Angle School of Orthodontia was held in 1900 with 11 students.

It has been said that Angle did not teach, he made his students learn through a rigid system of discipline. This covered every phase of their lives while they were with him from the preparation of their assignment in the theoretical subjects and the meticulous execution of their technical procedures, to the menial tasks of polishing and dusting their quarters and even sweeping the floors. Despite this his students left feeling that they had enjoyed the most thorough training available. They were clearly caught up by his enthusiasm and became, by and large, evangelists hurning to spread the gospel.

Angle showed that his criticism of the inadequate facilities was not purely destructive. He restricted his own practice, which had until then been a general practice, to orthodontics and became the first orthodontic specialist. He then set about establishing a teaching faculty in his own school. He persuaded teachers with training in medicine or in the basic sciences to assist him and the second class, held in 1902 had a staff of four in addition to Angle. There was a teacher in comparative dental anatomy, another in rhinology, a third in clinical and technical instruction and an assistant. This course lasted for five weeks and cost the participants \$150. Over the next nine years the duration of the course extended to a period of nine weeks and cost \$250.

The demand for places in the school was so great that by 1907 a preliminary selection examination was instituted to choose those best fitted to take part in the course. Candidates taking the examination were advised to acquire a knowledge of Noyes' Dental Histology, Kirk's American Text Book of Comparative Dentistry the chapter on tooth formation from Black's Anatomy and the anatomy of ear nose and throat after Gerrish.

In most classes a few of his students failed to pass the graduating exam. The requirements laid down by Angle for admission to the School of Orthodontia were:-

"1. You must have honesty and integrity.

2. You must have had at least a high school education before graduating from a truly reputable dental college.

3. You must not have been in general practice of dentistry longer than seven years. Experience has taught us that men become 'dentalised' so to speak, or so narrowed by the little things in dentistry as to seriously handicap them in the broad and profound study and practice of orthodontia.

4. You must be studiously inclined and have an aptitude and liking for orthodontia, must have a mind beyond the mere grasping of mechanics and must be willing to make orthodontia your life's study.

5. You must furnish letters from at least three well-known and reliable members of the profession as to your ethical standing, your education. Under no circumstances will anyone be received unless he can furnish such credentials. We would impress candidates with these final words; that credentials are essential, not a mere form, but that they are entirely useless unless they come from a well-known man of undoubted integrity in such matters. The ordinary letter of recommendation given in this country has degenerated into a mere farce; such letters will not be accepted."

Some of those who came to work as instructors became interested in orthodontics in its own right. For example, F.B.Noyes, the histologist who worked at North Western with G.V.Black, gave the first course in dental histology in the United States and dental photomicrography was said to have been born in his bathroom. Noyes came to lecture

in histology at Angle's request in 1904 and taught until 1908 when he took the course himself and then went back to Chicago to start a specialist orthodontic practice. He subsequently became Professor of histology and orthodontics at Illinois and then Dean of the University of Illinois in 1926.

Several orthodontic schools set up following the success of Angle's School and all based their approach on the teaching and techniques of Angle. The International School, of Orthodontia was set up in St.Louis and was later absorbed in Kansas City School and later Martin Dewey started the Dewey School. The same basic syllabus and the same concepts of orthodontic practice taught by Angle, were however taught in all these schools.

The graduates of the Angle School often went on to achieve eminence in their chosen fields, and to build on the foundation of this postgraduate training. Four members of the early schools - William Law from the 1903 school, Jane Bunker and Pfluger from 1904 and Grunberg from 1905 were founder members of the European Orthodontic Society. Harold Chapman was at the 1905 school, and he was a founder member of the British Society for the Study of Orthodontics.

F.L.Stanton also had a very hard childhood, this time because of a physical handicap. He had several operations on a deformed leg in his infancy and early childhood and this influenced his life, which subsequently was devoted to the welfare of the handicapped and underprivileged. After attending Angle's school in 1905 he returned to New York. When Angle retired from St.Louis in 1908 Stanton persuaded him to come there to

establish another school and he acted as Secretary and later as Secretary Superintendent from 1909. Through his efforts Raymond Osbourne was appointed a teacher in comparative anatomy; the best teacher the school ever had. In 1915 Stanton interested Hanau in instruments for mapping the denture and this was the beginning of Hanau's interest in dentistry. Stanton went on to become Professor of Preventative Dentistry and Occlusion in the New York University College of Dentistry in 1927. A year later he was also made Professor of Orthodontics. In 1930 he organised the division of child research which became a long term study of growth and development of the dentition and in 1932 he retired from practice, devoting himself quite successfully to this project.

Milo Hellman was a musician and a researcher. Born in Rumania, he came to America at the age of 16, and was a flautist with the Pittsburg Symphony Orchestra. He saw no future in being a musician and saved up enough money to graduate in dentistry and graduate from the Angle School in 1905. He then studies vertebrate palaeontology at Columbia and subsequently divided his activities between dentistry and anthropology. He introduced anthropometrics and cephalometrics to orthodontics and he also made anthropologists aware of the significance of the growth and development of the face and dentition in their work. He established many of the basic measurements on dried skulls that paved the way for X-ray cephalometry.

Participants in the 1909 session too went onto make significant contributions to the specialty and their teachers were no less distinguished. Martin Dewey had a hard struggle as a child. He was brought up on a farm on the Kansas plains at a time when farmers were literally struggling to stay alive. The tenacity of purpose and will to succeed that

lifted him from this background carried him to the top of his profession. He was an outstanding debater and public speaker and he defended Angle's non-extraction teaching in an historic debate with Calvin Case in 1912. Despite the hard word that were used on both sides in this debate Case and Dewey both maintained their respect for one another and agreed that when men differ it is only by full and frank discussion that they can hope to arrive at the truth. Dewey separated from Angle in 1911 after a disagreement and he began the Dewey School in Kansas City, subsequently becoming Professor of Orthodontics in Iowa. He moved to Chicago and then to New York and established a Postgraduate school in each city. As well as becoming President of the American Association of Orthodontics, he became President of the American Dental Association. He was always conscious of dentistry's mechanical origins and was a strong campaigner for professional integrity. He fought the Arizona state law which sought to impose treatment techniques on orthodontists. He was the first editor of the American Orthodontist and subsequently the first editor of the International Journal of Orthodontia which became the American Journal of Orthodontics, the most widely published orthodontic journal.

B.W. Weinberger, in addition to practising orthodontics, devoted himself to recording the history of dentistry and of orthodontics and his writings in countless journals are said to have exceeded the output of any other author.

Sheldon Friel was a student in the class and subsequently became Professor of Orthodontics at Dublin. In the 1930's he and deCoster of Belgium were the first to make practical use of stainless steel in orthodontics. He developed the orthodontic welder and

also designed numerous spring forms in stainless steel many of which are still in use or are being regularly rediscovered by new orthodontics. he also produced the classical work of the development of the occlusion. ¹⁸ He was the only non-American to be honoured with the Albert Ketcham Memorial Prize which is awarded for outstanding work in orthodontics and in the citation he was described as the outstanding orthodontist in Europe.

A. Le Roy Johnson was accepted at Tuft's University and graduated with a Ph.D. in Medical dentistry in 1904. After graduating from the Angel school in 1909, he set up an orthodontic practice but rapidly became aware of the varied response to purely mechanical treatment and he sought out biologists concerned with child growth, for he believed that the answer lay in this field. Later he invited one of the scientists to give a paper at a meeting of prominent orthodontists in which the biologist pointed out that normal and ideal were not necessarily synonymous and that a range existed within healthy and well adjusted individuals, and furthermore that the development of the dental apparatus was genetically and environmentally controlled. This was regarded as heretical and offensive. Johnson first taught at Tuft's but his attempts to introduce biological principles to dental students whose minds were saturated with mechanics was like trying to build the foundation of the house after the house was built. He moved to Boston and taught at Michigan but when he presented a paper on diagnosis to the local orthodontic society and illustrated it with cases in which the malocclusion had been eliminated by normal development he was taken aside and rebuked by his Dean. After a period as Professor of Pennsylvania he returned to New York where he worked with Stockhard at Cornell medical school. They worked on what was intended to be endocrine research on

dogs but soon found that some characteristics which had been believed to be endocrine were in fact genetic and that the skull, maxilla, mandible and teeth were under multiple genetic control. This confirmed Johnson's convictions that dental techniques, however refined were not alone the solution to dental problems. He convinced the Dean of Yale medical school of the need for broader dental training and both Yale and Rochester were persuaded to accept dental students for wider training in the basic sciences. In 1942 Johnson was made Administrative head and Associate Dental of the Faculty of Medicine and the work of establishing a new dental educational system had been largely completed by his retirement in 1947.

Albert Ketcham graduated in Boston in 1892 but contracted tuberculosis and had to move to Colorado at the turn of the century. The open air life contributed to his recovery and when he was almost fully recovered he opened a dental office in Colorado, where he had a saddle constructed into a dental chair so that his cowboy patients felt at ease. He was a close friend of two medical specialists, a rhinologist and an ophthalmologist both of whom were concerned in the establishment of registration boards for their specialties. The first two medical specialties to be recognised as such and to have a Registration Board were Ophthalmology and Otolaryngology. The third specialty ever to develop a Registration Board was in fact orthodontics; Ketcham was involved in establishing the American Board of Orthodontics which was founded in 1930 and became its first president.

The foundation of the Angle School of Orthodontia marked the beginning of postgraduate education in dentistry, and led to the establishment of orthodontics as

specialty. The influence of the school spread all over the world, and graduates of the school from America, Europe, Australia and South Africa stimulated new enthusiasm and interest in orthodontic education and practice. Many of these were original thinkers who questioned traditional concepts that conflicted with their clinical observations and their quest for truth extended orthodontic thinking far beyond the confines of tooth straightening, into the field of anthropology, genetics, histology and human growth and development.

Angle, despite his dogmatic teaching much of which has not stood the test of time, played an outstanding role in the development of orthodontics. We all owe a debt to the past and the work of generations of dentists who had a part to play in the development of orthodontics and dentistry as we know it.

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DENTAL ASPECTS OF THE SPITALFIELDS EXHUMATIONS

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This paper is based on studies of the dentition of bodies exhumed from the crypt of Christchurch with All Saints, Spitalfields in the East End of London. The exhumations took place between October 1984 and September 1986 and they were conducted by a team of professional archaeologists. It was my privilege to be associated with the studies carried out by the Department of Palaeontology, British Museum (Natural History) and I am indebted to the Museum for the facilities provided by them.

Christchurch Spitalfields was designed by the architect Nicholas Hawksmoor and was constructed in the second two decades of the 18th century. Burial records reveal that between its consecration in 1729 and February 1859, about 68,000 individuals were buried, either in the graveyard or in the crypt of the Church itself. During the last 20 years the Church has been considerably modified and structurally improved and this plan necessitated the exhumation of internments in the crypt. This programme was carried out under Home Office licence and the details of the archaeological activity have been reported elsewhere¹. The scientific study is an extremely important one since there are very few documented studies of the skeletal remains of 18th century Londoners and in this particular case, a large proportion of the exhumed bodies could be named and the date of death and age at death were known from coffin breastplates and from burial records. This offered the opportunity of checking the ageing techniques available to anthropologists and dentists, as well as allowing a study of the oral pathology and dental artifacts of this period. The oldest remains in the crypt at Spitalfields were of individuals

born in the second half of the 17th century and the youngest were those dying in the second half of the 19th century. A considerable number were associated with the Huguenot population of the East End of London. Over 1,000 bodies were recovered from the exhumation and of these, 387 individuals were identified by name and age and these were the ones studied in details in relation to growth studies, maturity, ageing techniques and medical and dental pathology.

Entry to the crypt was restricted initially because of the possibility of viable smallpox virus but after investigation of sample coffin contents it was demonstrated that this was not the a possibility. Many of the coffins were arranged in a haphazard manner, standing in some cases on their ends and in many cases heavily compressed by coffins placed above them. There was also a large amount of debris surrounding the coffins, some of which was of charcoal nature and had been placed there to prevent odours from penetrating to the Church above. All of this meant that the archaeological excavation of the crypt an extremely difficult task and was carried out in most unpleasant circumstances.

Preservation of the bodies was variable, ranging from complete preservation including skin, hair and internal organs to sediment of crystal debris being all that remained of the bone. The well-preserved individuals were immediately cremated and in all 42 bodies were dealt with in this way. As a general rule the teeth, being the most heavily mineralised part of the body, are the least destructible. They may, however, be vulnerable to post mortem loss and this applied to some of the material exhumed at Spitalfields.

Preservation of the teeth in ancient specimens has enabled dental anthropologists to comment upon the prevalence of conditions such as dental caries throughout the ages, as there is evidence that the carious process is arrested at death. In most populations, especially like Spitalfields where attrition rates in the teeth were low, the caries prevalence identifiable today is a measure of the untreated condition at the time of death. It has been suggested that the prevalence and distribution of dental caries is related to the progression of civilisation and the refinement of their diet, although many other factors are now known to influence caries prevalence. The increase in dental decay with changes of habit and diet have been catalogued by Hardwick² from Neolithic times through until the middle of the 20th century, and extensive data are available in the literature concerning prevalence of decay in the Romano-British and Anglo Saxon periods, although are singularly rare in the period covered by the Spitalfields burials. This is because the consecration of Christian burial grounds has resulted in few opportunities for large scale exhumation and consequent scientific study.

All of the persons pre-dated modern day dentistry, although they were living at a time when the dental profession was being established, and charlatans and untrained practitioners were well known in London society. John Gray, a member of the Royal College of Surgeons writing in 1837 said,

"The great number of persons who have lately assumed the character of surgeon-dentists, without possessing the accomplishments of either the surgeon or of the mechanic....One of the greatest mischiefs inflicted by quacks is the odium and distrust their malpractice bring upon the profession which they invade."³

ORAL PATHOLOGY

Work is still continuing to detail all the pathology represented in the Spitalfields collection but at this stage some guidelines can be given as to the expected findings. Horizontal bone loss in the sample seemed to be minimal and out of a sample of 90 skulls, vertical bone loss was seen in 25, and in 14 of these was characterised as severe, exposing up to two thirds of the length of the tooth roots. In the adult section of the exhumed skeletons malocclusion seemed to be rare, there being one case of anterior open bite in the sub-sample, one of severe crowding, and impacted wisdom teeth were only seen in four of the 90 skulls examined. Other than minor misplacement of teeth, severe rotation was only seen in three cases. In this subpopulation teeth which were judged to be absent congenitally were a fairly rare event, there being nine cases with one congenitally absent tooth, four with two, two with three and eight in which four teeth were judged to be congenitally missing. In two cases there were extra molars present which were judged to be nines and there was one case exhibiting peg shape laterals. Markedly hypoplastic teeth were not commonly seen but were present in four cases and gross attrition of occlusal surfaces was only present to two skulls. This may indicate a softer diet and perhaps in those cases the presence of bruxist habits. As will be seen later, the prevalence of caries was quite high in the sample as a whole and it is therefore not surprising that a number of apical abscesses were seen. Twelve individuals had one abscess, two had two, three had three and one had four or five abscesses. In one case there was a very large cyst present in the upper anterior region and in another a large palatal defect perhaps indication tertiary syphilis or another granulomatous lesion.

DENTAL CARIES

A number of studies have been published from Neolithic Bronze Age and Iron Age specimens ⁴, Romano-British ^{5,6}, Anglo Saxon times ^{7,8}, although there have been only a few studies from the plague years of 1665 through to London populations of 1834 ^{9,10}. These studies have suggested that caries incidence in Romano-British times was low but may have been higher in settlements close to coastal habitation where there were direct trade routes with the Mediterranean. Extrapolating from the graph produced by Hardwick ¹¹ it would be expected that around 18% of teeth in a population similar to Spitalfields would exhibit evidence of dental decay.

Although some 387 bodies of known age and provenance were present in Spitalfields, some 93 skulls were selected for this caries study because they were well-preserved, having at least twelve teeth present and their ages and names were known. Twenty individuals had 26 teeth present, 13 has 28 and five of the total sample had all 32-teeth present. The skulls were assigned to five age groups so that caries prevalence as age progressed could be studied: ages 2-16; 17-25; 26-36; 37-55; 56-77 years. There were some 21 individuals in this oldest age group, three of whom were 72 years of age and one whom was aged 78. Standard dental charts were used to record the teeth present, teeth missing ante mortem and post mortem and those congenitally missing. Caries lesions were charted using a probe and the naked eye and the exact position and size and shape of the lesion was indicated on the chart. Radiographs were taken both of right and left hand sides of the mandible and maxilla as a check on diagnostic accuracy. We examined more than 2,000 teeth from 93 individuals and of these 16% had been lost before death, and just over 12% after death. This therefore constitutes a very satisfactory sample for caries prevalence studies. Since we cannot know what percentage of the teeth that were

missing were carious or were lost ante mortem from caries rather than periodontal disease, the final determination of prevalence of caries will be an under estimate.

A high proportion of the skulls examined had suffered from decay in one or more teeth. A surprising finding was that even in the juvenile group 73% of individuals had experienced some decay and in the middle age group this had risen to 100%. Overall more than 77% of all the individuals studied had experienced caries attack. Caries was age related but was remarkable high in the youngest age group. When caries is expressed as a percentage of the teeth at risk, 14% were carious up to the age 25 years and by the of 26-35 years, 23% of teeth were carious. Of 2,140 teeth examined 17.5% were carious.

As regards caries distribution, 12% of all occlusal surfaces at risk were carious, and although it has been shown that approximal caries tends to increase in populations eating highly cariogenic diets, in the Spitalfields sample over 4,000 approximal surfaces were at risk, and of these 5.5% were cariously involved. Buccal and lingual lesions were less frequently seen and comprised only 2.5% of the surfaces at risk.

Although root caries is said to be high in modern civilisations where chronic infective periodontal disease had exposed the roots of the teeth, in Spitalfields root caries was rare in the juveniles (only 0.9%) and even in the oldest age group only reaches 1.8% of the surfaces at risk. The overall prevalence of caries was calculated at 17.6% and this is close to the predicted level from the work of Hardwick, but the distribution shows a shift particularly towards approximal surfaces at the expense of occlusal surfaces. This may be

19th century. At the same time, Fox working at Guy's Hospital, was advocating the use of bismuth, lead and tin alloy and it is not clear which type was used in the single Spitalfields tooth.

in another two individuals a compressed gold foil appeared to have been used, condensed into unprepared carious cavities following excavation of the bulk of the caries. In one case (case number 2258) the foil had been condensed across the approximal space whilst in the other (2872) there were gold fillings present in six teeth but caries had recurred around most of them. This was the skull of Eliza Favenc who dies in 1809 at the age of 27 years.

ARTIFICIAL REMOVABLE AND FIXED DENTURES

Nine of the bodies exhumed in Spitalfields were wearing dentures at the time of their burial. This is a relatively small number but it is not known whether it was the custom to remove dentures before burial. Those that were present provide a unique insight into the design and construction of such artifacts and they represent probably the largest number of dentures of known provenance.

NUMBER 2075

Unfortunately the name and the age at death are not known for this particular individual. When the denture was fitted, teeth 3 2 and 3 3 were present in the mouth, but had been lost subsequently before death, resulting in some healing of the lower ridge. The prosthesis consisted of both upper and lower dentures which, when examined, were separated but which had originally been connected with coiled springs. The upper

prosthesis was of the swaged metal base type covering the alveolar ridge but not the hard palate. The metal was probably gold alloy or a similar material. the teeth attached to the metal base-plate were of fired porcelain, probably individually fashioned to precisely fit the base plate and were attached to it by means of gold pins sliding in gold tubes through the centre of each porcelain tooth and running through to the occlusal surface. There was evidence of only minimal wear on the dentures suggesting that they had been fitted not long before death. The lower prosthesis consisted of a similar base plate replacing 4 1 to 4 7, 3 1, 3 4 to 3 7 and gum fitted around 3 2 and 3 3. There was a rotary rivet for a coiled gold wire spring in the 4 6, 4 5 area and a hole in the upper base plate above 1 4. There was no evidence of a spring on the left side of the dentures, the lower denture presumably being retained by the standing teeth 3 2 and 3 3.

NUMBER 2394

Again the name and age at death of this person were unknown. The base plate was carved from a block of ivory, probably from the hippopotamus, and replaced 4 4 to 3 2, being gum fitted around 4 5 and 3 3. The front teeth were poorly characterised and had the appearance of parallel sided, rather long teeth; this appearance being produced by the facing of the original animal tooth from which the base plate was carved. There were perforations for silk ligatures and the fitting surface appeared to be hand carved and probably fitted over retained roots or a bony protuberance. Carved dentures of this nature were common around the end of the 18th century.

NUMBER 2930

This lady was named Deborah Peck who died on 26th November 1739 aged 35 years. The denture specimen consisted of two natural teeth which had been lost post mortem and around their necks were silk ligatures supporting two carved replacements for 2 1 and 2 2. The two carved replacements appeared to be of ivory faced with the original enamel of the animal tooth from which they were made. Such a denture would have permanently tied in the mouth and would not have been removable for cleaning.

NUMBER 2221

This was the mortal remains of Charles Shaw Lefevre who dies in April 1823 at the age of 64 years. He was a barrister and landowner and extremely rich. The lower partial denture consisted of a gold swaged construction fitting over lower molars on the right and left side. It was made from a sheet of gold plate cunningly cut and folded around the molars and the occlusal surfaces over the teeth had been separately covered and welded onto the plate. An interesting feature was the presence of a gold pin rivetted on the inner surface of the molar covering and presumably fitting and anchoring onto a prepared cavity in the underlying tooth. Natural teeth were fitted on to gold pins rivetted through the gold base plate. In the region of tooth 4 3 a separate piece of gold was rivetted to the base plate and carried a silver block to which a single tooth had been fitted, possibly in the form of an immediate partial replacement. There were coiled gold wire springs on either side of the base plate and these would have been inserted into an upper prosthesis now missing.

NUMBER 2224

The age at death and name were unknown. The dentures consisted of both upper and lower metal base plates, the upper being a swaged plate presumably of low gold alloy and gum fitted around the anterior teeth. The plate carries rivetted pins supporting seven teeth all of which seemed to be natural human teeth. The lower denture was carved from ivory or dentine block extending occlusally into two blocks in the 4 7 to 4 5 and 3 6, 3 7 regions and again rivetted natural tooth crowns were present in 4 4, 4 3, and 3 1 to 3 5. There was a coiled wire spring attached via a rotating rivet to the occlusal block region 4 5, although the upper attachment of this spring had been lost.

NUMBER 2238

The name and age at death were unknown. The well preserved prostheses in this individual consisted of upper and lower base plates carved from ivory, the upper plate being gum fitted around 1 2, 2 2, and replacing 1 3, 1 1, 2 1, 2 3, by natural tooth crowns rivetted via gold pins. The upper plate was horse-shoe shaped and did not cover the whole palate but was attached by rotating rivets and coiled springs to a similar lower plate carved from ivory.

NUMBER 2058

The name and age at death were unknown. The denture found in the skull at the time of recovery consisted of a carved bony base plate replacing 2 1 and 2 2, these teeth appearing to have been cut off at gum level leaving the roots in situ. There is evidence in the skull of apical abscess overlying the apices. The dentist has replaced the two missing teeth by three artificial teeth made from facings from the retained enamel of the

animal from which the plate was carved. At either end of the base plate silk ligatures running through holes in the base plate presumably attached it to 1 1 and 2 3. It was probably constructed in the latter part of the 18th century since there is evidence that ligatures were falling into disfavour by about 1800.

NUMBER 2910

This was the remains of Mr William Laschallas, a wholesale stationer and manufacturer, dying in December 1852 at the age of 57 years. the gold denture present in the anterior region could not be removed from the skull because of the excellence of its fit. It consisted of a small gold base plate extending from 1 5 to 2 4, being gum fitted around these teeth and also around 1 3, 1 1 and 2 1. the gold base plate carried four teeth inserted onto gold rivet pins extending through the base plate itself. The teeth appear to be of porcelain individually made to fit the base plate. The overall aesthetics of this remarkable fixed denture would probably have been quite acceptable. It may have been made by swaging onto a dye made from primitive impressions in wax of the mouth and then modified to fit the patient's own mouth.

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COVER ILLUSTRATION FOR DENTAL HISTORIAN NO21

The illustration is taken from a copper engraving by Luigi Guidotti of Bologna, entitled Der Zahnreisser, and dated circa 1625.

The patient is seated on the ground, while the operator, seated on the trestle table behind him, extracts a tooth.