

## *A Brief History of Orthodontics*

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Man's ancestry may be traced back for more than one hundred millenia. One of the earliest known types of man is Neanderthal Man. The name is derived from a valley in western Germany where the skeletal remains were found in 1856. He was distinguished by a stocky, heavily muscled build, proportionately short forearm and lower leg, and an extremely dolichocephalic skull with projecting occiput, heavy supraorbital tori, receding forehead, and underdeveloped chin.

Another type of man in the early Pleistocene period was Heidelberg Man. His skeletal remains—the famous Heidelberg jaw—consisted of a massive fossilized chinless jaw with distinctly human dentition. The specimen was discovered in 1907 near the town of the same name.

Next in the ancestral line of man is pithecanthropus, a primitive man that is known from a skull and other bone fragments found near the village of Trinil, Java, in 1890. The profile is similar to that of the ape, with a very low forehead and an undeveloped chin. The teeth are characteristically like those of human beings.

Another link is the sinjanthropus, whose skeletal remains were discovered near Peking, China, in 1929, and is also known as Peking Man. Skulls, many teeth, and other skeletal parts reveal a close anatomic relationship to pithecanthropus. It is considered "close to the main line of descent to modern man."

It was not until the postglacial period, which extended back 30,000 to 40,000 years, that modern man, *homo sapiens*, appeared. The Cro-Magnon Man is an outstanding representative of the first "true man." Many of his skeletal remains have been found in various parts of Europe. The name is derived from a cave near Les Eyzies, France. The shape of the skull, face, and brain are characteristic of the modern Caucasian man, except for the difference in size.

During the years from prehistoric time, man has undergone certain evolutionary changes. These changes include the development of an increased cranial capacity; the change in the skull conformation; a heightening of the forehead and a receding of the brow ridges; the reduction of the dental and jaw arches that gave form

and prominence to the chin; the progressively human-like appearance of the teeth; and the increase in stature, with the body becoming more erect.

Contrary to popular belief, early man also suffered from dental and oral diseases. This was probably because of the type of food he ate and altered occlusion due to excessive wear, causing edge-to-edge or a minimal overbite pattern.<sup>1,2</sup>

### ANCIENT CIVILIZATIONS

The history of orthodontics has been intimately interwoven with the history of dentistry for more than 2000 years. Dentistry, in turn, had its origins as a part of medicine.

To properly study our orthodontic origins, we must return to the Greek civilization of the preChristian era. The Greek physician Hippocrates (460 to 377 BC) is revered as a pioneer in medical science, chiefly because of his medical authorship. He was the first to separate medicine from fancy or religion, and with his reports of critical observation and experience, he established a medical tradition based on facts. This collected information was gathered into a text known as the *Corpus Hippocraticum*, the medical testament of the pre-Christian era.

This treatise does not discuss the dental art independently but contains many references to the teeth and the tissues of the jaws as part of the medical text. An example:

... the first teeth are formed by the nourishment of the fetus in the womb ... the shedding of the first teeth generally takes place about seven years of age. Children who cut their teeth in winter time get over the teeth period best. Among those individuals whose heads are long-shaped, some have thick necks, strong members and bones; others have strongly arched palates; thus teeth are disposed to irregularity, crowding one on the other and they are molested by headaches and otorrhea. (*Epidemics*, chapter: de caribus.)<sup>3</sup>

Aristotle (384 to 322 BC), the Greek philosopher, had equal stature in the fields of statesmanship, art, and biology. His interest in biology gave to medical science the first system of comparative anatomy and the studies of zoology and physiology. He was the first writer who studied the teeth in a broad manner, having examined them in relation to the dentitions of various types of

animals. He may be regarded as the first comparative dental anatomist because, in his famous work entitled *De Partibus Animalium (On the Parts of Animals)*, he compared the various dentitions of the known species of animals of that time. He noted that there were marked differences between human teeth and those of animals and, in fact, differences between the different species of animals. He described the dental apparatus of the viviparous animal, distinguishing between teeth, tusks, and horns.

Aulus Cornelius Celsus (25 BC to AD 50), one of the prominent Roman medical authors of the first century, wrote in *De Re Medicina (On Medicine)*:

When in a child a permanent tooth appears before the fall of the milk tooth, it is necessary to dissect the gum all around the latter and extract it. The other tooth must then be pushed with the finger, day by day, toward the place that was occupied by the one extracted; and this is to be continued until it reaches its proper position.<sup>5</sup>

The medical art of the Romans reached its zenith under Claudius Galenus, commonly known as Galen (AD 130 to 200?). For 15 centuries he dominated medical thought, and it was not until the Renaissance that the infallibility of his medical expertise was questioned. In his medical writings, he described dental anatomy and embryology by specifically identifying the origin, growth, and development of the teeth and enumerating the functions of each. He believed the teeth to be true bones. Because dissection was performed on animals rather than on human beings, he erroneously applied some of his findings to human beings (e.g., the presence of an intermaxillary bone and the insensibility of teeth).<sup>5</sup>

#### MIDDLE AGES (476 to 1450)

There is very little reference to dentition during this period, with one exception. An Arabic physician, Paulus Aegineta (Paul of Aegina) 625 to 690), wrote:

When supernumerary teeth cause an irregularity of dental arches, they may be corrected by resection of such teeth or by extraction. In case one projects above the level of others, the part protruding should be removed by means of a file (*epitome*).<sup>5</sup>

He also stated that irregular teeth were "displeasing in women."<sup>6</sup>

#### RENAISSANCE PERIOD (Fourteenth to sixteenth century)

During the Renaissance, one of the greatest geniuses of history, Leonardo da Vinci (1452 to 1519), is remembered because he painted a smile on the lips of Mona Lisa. Her smile remains most provocative; yet the brush was only one of the many tools he mastered. He was the first artist to dissect the human body for the

acquisition of anatomic knowledge and the first to draw accurate pictures of these dissections.

Leonardo was the first to recognize tooth form and the first to realize that each tooth was related to another tooth and to the opposing jaw as well, thus perceiving the articulation of the teeth. He described the maxillary and frontal sinuses and established their relationship to facial height. He determined and made drawings of the number of teeth and their root formations. He noted that "those teeth that are the farthest away from the line of the temporomandibular articulation are at a mechanical disadvantage as compared with those that are nearer."

Those (teeth) that act most powerfully, the *mascellari* (molars) have broad flattened crowns suitable for grinding the food, but not for tearing or cutting it; those that act less powerfully, the incisors, are suitable for cutting the food but not for grinding it; while the *maestre* (canines) are intermediate between these two sets, their function being presumably that of tearing the food.<sup>1</sup>

Andreas Vesalius (1514 to 1564), a Belgian physician and anatomist, set a precedent in the study of human anatomy when he personally performed a dissection. It had been the custom for students to do the dissections while the lecturer described the procedure and specimen. He proved Galen wrong in many areas of anatomic knowledge. His classic work, *On the Fabric of the Human Body*, became the foundation that reconstructed our knowledge of human anatomy and thereby laid the basis for the practice of medicine and surgery.

In this book, he described the minute anatomy of the teeth, particularly the dental follicle and subsequent pattern of tooth eruption:

We believe that only the teeth among the bones are given the perceptible faculty of sensation by certain small soft nerves, propagated by the third pair of cranial nerves and implanted at their roots . . . the Almighty Artificer of things deservedly is to be praised Who, we believe, liberally bestowed the noteworthy faculty of sensation on the teeth alone among the rest of the bones. For He knew that they will frequently encounter objects which might cut, break, or scratch them, unduly heat or chill them, or affect them in some other way. . . . Consequently, had they no power of sensation, Man would not be warned by pain and would not protect the tooth by avoiding the injurious agent before the threatened teeth are damaged. There are usually thirty-two teeth in all, a single series of sixteen in each jaw, most fittingly placed in the form of a semi-circle. The first four front teeth, because they cut, are called incisors; next come the canines placed singly at each side, to have torn apart that not done by the incisors. They receive their name because of their resemblance to the outthrust of dogs. After them are the *maxillares*, or molars, five on each side, rough, broad, hard and large by means of

which food cut by the incisors and broken up by the canines can be ground to perfect smoothness.<sup>1</sup>

Ambrose Paré (1517? to 1590), a French surgeon, paid specific attention to dentofacial deformities, especially to the cleft palate. He was the first surgeon to devise an obturator for treatment. Crude as these appliances may seem, there was no appreciable advance for more than 3 centuries.<sup>1</sup>

Gabriele Fallopio (1523 to 1562), commonly known as Fallopius, an Italian anatomist, wrote in his *Observationes Anatomica (Anatomic Observations)* a detailed description of the dental follicle. He also gave us the terms *hard* and *soft palate*.

A membranous follicle is formed inside the bone furnished with two apices, one posterior (that is to say, deeper down, more distant from the gums), to which is joined a small nerve, a small artery and a small vein; the other anterior (that is, more superficial) which terminates in a filament . . . inside the follicle is formed a special white and tenacious substance, and from this the tooth itself, which at first is osseous only in the part nearest the surface, whilst the lower part is still soft, that is, formed of the above mentioned substance. Each tooth comes out traversing and widening a narrow aperture . . . bare and hard; and in process of time the formation of its deeper part is completed.<sup>1</sup>

Bartholomaeus Eustachio (1520 to 1574), commonly known as Eustachius, also an Italian anatomist, described the minute structure of many organs, especially the tube that connects the middle ear with the nasopharynx and that bears his name. He wrote *Libellus de Dentibus (Book on the Teeth)* in 1563, which is the first important specialized monograph on the anatomy of the teeth. In this book, he collected the writings of various authors from Hippocrates to Vesalius, added the results of his own researches, and gave the first accurate account of the phenomenon of the sequential development of the first and second dentitions. He described the eruption and the function of the teeth, contending that there was no analogy between the deciduous and permanent dentitions. Eustachius devoted more attention to the teeth than most anatomists, giving full descriptions of the different forms, number and varieties. He indicated the manner of articulation of the teeth and gave a somewhat ambiguous explanation of the nature of the attachment of the teeth to the socket and the gingival tissues, comparing the latter to the attachment of the nails to the skin. His explanation of the internal structure of the teeth differentiated the two layers and compared the enamel with the bark of trees.

Eustachius described the dental follicle and its blood supply. He refuted the doctrine that roots of the deciduous dentition served to form the permanent teeth. He

maintained that the germs of the permanent teeth are too small to be seen in the fetus. He also mentioned that the teeth are nourished differently than other bones, as witnessed by their inability to repair when fractured.<sup>1</sup>

The first book in the German language to have reference to the teeth was entitled *Arzei Buchlein (A Book of the Surgical Art)* and was published in 1530 (author unknown). It contains the following comment:

When teeth begin to drop out . . . push the new one every day toward the place where the first one was until it sits there and fits among the others, for if you neglect to attend to this, the old teeth (deciduous) will remain and the young ones (permanent) will be impeded from growing straight.<sup>6</sup>

## EIGHTEENTH CENTURY

France became the leader in dentistry throughout the world in the eighteenth century. This was primarily attributed to one man, Pierre Fauchard. No one person exerted a stronger influence on the development of the profession than he did. In fact, he is referred to as the "Founder of Modern Dentistry." He created order out of chaos, developed a profession out of a craft, and gave to this new branch of medicine a scientific and sound basis for the future.

The results of his labors are reflected in the publication of his two-volume book entitled *Le Chirurgien Dentiste, ou Traite Des Dents (The Surgeon Dentist, A Treatise on the Teeth)* completed in 1723 and published in 1728. It was the work that heralded the advent of the dental art based on fundamental knowledge. Three editions appeared in France, but it was not until 1946 that an English-language edition was printed.

With reference to orthodontics, as early as 1723, he developed what is probably the first orthodontic appliance. It was called a *bandolet*. It was designed to expand the arch, particularly the anterior teeth and was the forerunner of the expansion arch of modern times.

If the teeth are much out of line and cannot be corrected by means of threads, it is necessary to use a band of silver or gold. The width of the band should be less than the height of the teeth to which it is applied. The band must neither be too stiff nor too flexible. Two holes are made at each end, a thread passing partially through forms a loop in the middle of each thread . . . by the pressure and support given the band the inclined teeth will be made upright for a short time.<sup>7</sup>

Fauchard described 12 cases of orthodontic treatment in patients whose ages ranged from 12 to 22 years, with apparently good results. Other treatment procedures included the filing of teeth, especially for crowded anterior teeth, and the use of a special forceps called the *pelican*, named for its resemblance to the beak of that bird.

Making use of the file, I began by separating the tooth from the neighboring ones which pressed upon it, slightly diminishing the space it ought to have occupied. This done, I straightened the tooth with the pelican, placing it in its natural position . . . no sooner had I reduced the tooth to its normal position I fixed it to those next to it by means of a common thread, which I left there for eight days.<sup>7</sup>

He seldom had recourse to extraction and urged attention to the deciduous teeth.

Another important French dental surgeon was Robert Bunon (1702 to 1788), who wrote in his book entitled *Essay on the Teeth*:

I claim that a good formation of the teeth can be procured if care is given them from the earliest age. I even go further and I say that the tooth germs and the tooth materials are favorably disposed by the regimen of the prospective mother. . . . One child, by the state of his teeth, appears too young at fifteen or sixteen years of age for certain operations, which for him may be premature, and another child of eleven or twelve years old, may sometimes have waited so long for a remedy that, in this case, it is already too late.<sup>1</sup>

In 1757 Etienne Bourdet (1722 to 1789), the dentist to the King of France, advocated the Fauchard method but went a step further by recommending only gold strips on the labial surface for the upper arch and on the lingual surface for the lower arch.

He wrote in his *Recherches et Observations sur Toutes les Parties de L'art du Dentiste (Researches and Observations on Every Branch of the Art of the Dentist)*:

The strings should be removed and retightened twice a week, until the teeth have resumed their proper position—that is to say, until the teeth of the upper jaw are drawn forward so that no part of them is hidden behind those of the lower jaw.<sup>1</sup>

Bourdet differed with Fauchard in that he recommended the extraction of the first premolars to preserve symmetry of the jaws. In children who had protruding chins, Bourdet corrected this by extracting the mandibular first molars shortly after eruption.

In England, John Hunter (1728 to 1793), a great teacher of anatomy, is numbered as one of the foremost surgeons of his day. Hunter left a valuable array of publications, one of which, *The Natural History of the Human Teeth: Explaining Their Structure, Use, Formation, Growth and Diseases*,<sup>8</sup> is of particular interest. It was published in 1771 and initiated a new era in dentistry by placing dentistry on the basis of scientific observation at a time when empiricism was rampant. Hunter's descriptions of the formation and the growth of the teeth and jaws excelled anything previously published. He demonstrated the growth, development, and articulation of the maxilla and mandible with the attached musculature and outlined the internal structure

of the teeth (enamel) and bone (dentin) and their separate functions. His innumerable experiments and observations of case histories established the difference between bone and teeth for the first time. Because he improperly prepared the specimens, in that he had failed to inject disclosing material in teeth during a series of experiments, he erroneously concluded that teeth were "nonvascular." For the nomenclature of dentistry, he labeled incisors, bicuspid, and molars.<sup>1,4</sup>

Robert Blake, a disciple of Hunter, followed in his footsteps of scientific inquiry, as demonstrated by his thesis presented to the University of Edinburgh entitled "On the Structure and Formation of the Teeth in Man and Various Animals." It was published in 1798. The following is an excerpt from the text:

I feel myself justified that the alveolar arches continue to increase during the entire progress of the formation of the teeth. It is, however, sufficiently evident that the greatest increase of the jaws is backward . . . we frequently meet with disproportions between the jaws and teeth, and in such that the permanent teeth never would become regular without the assistance of the art.<sup>4</sup>

In Germany during the eighteenth century, little attention was paid to the dental art. However, we should note that Gottfried Janke attributed the shedding of deciduous teeth to the obliteration of their vessels by the compression of the erupting permanent teeth. Adam A. Brunner (1737 to 1810) advised that "milk teeth should never be extracted unless there be manifest signs of the presence of the corresponding permanent teeth, or when it is painful or decayed."<sup>9</sup>

## ORTHODONTICS IN THE UNITED STATES

In Colonial America, primitive conditions for dental care existed for almost a century until European-trained "operators for the teeth" came to this country seeking fresh opportunities. The art of dentistry in America can be said to have had its origin with the importation of these practitioners to the colonies.

One of the most important native practitioners was John Greenwood (1760 to 1819). His skills were first learned from his father, who was an instrument maker. He was apprenticed to Dr. Gamage, who taught him the rudiments of the dental art. Through experience, he became proficient in the practice. He was a strong advocate of the care of children's teeth. He published the following advertisement in 1797<sup>10</sup>:

Parents and Guardians. As the attention that is necessary to be paid to children's teeth at the time of shedding and after being of so great importance to their regularity, evenness and future preservation, needs no observations. Mr. Greenwood is induced by the patronage of many families, to reduce his

prices for taking the sole care of children's teeth by the year, to give everyone an opportunity to be benefitted by him. For four children and upwards, in one family per year, one guinea. For one child per year, ten shillings to be paid when the year is out from the time of entering.

Other practitioners include Josiah Flagg (1763 to 1816) of Boston, who advertised that he "regulates teeth from their first teeth, to prevent pain and fevers in children, assists nature in the extension of the jaw, for a beautiful arrangement of a second set of teeth."<sup>11,12</sup> In 1798 C. W. Whitlock of Philadelphia stated that he "supplies the deficiencies of nature . . . files, regulates, extracts . . . teeth." John Le Tellier, also of Philadelphia, "regulates teeth from their first cutting in children." (1804). B. Fendall of Baltimore advertised that he "regulates the teeth of children" (1784).

Leonard Koecker (1728 to 1850), practicing in Philadelphia, advertised that he "supplies ligatures to teeth of an irregular position." He stated in his published articles in the medical press (1826)<sup>13</sup>:

Irregularities of the teeth is one of the chief predisposing causes of disease, and never fails even in the most healthy conditions to destroy, sooner or later, the strongest and best set of teeth unless properly attended to. It is not only a most powerful cause of destruction of the health and beauty of the teeth but also to the regularity of the features of the face, always producing, though slowly, some irregularity, but frequently the most surprising and disgusting appearance. It is, however, a great pleasure to know that dental surgery is abundantly provided with a remedy, and in most delicate subjects if placed under proper care at an early age, the greater portion of the teeth of the permanent set may invariably be preserved to perfect health and regularity.

A note about his recommendation for extraction. He advocated the extraction of first molars "since they are generally predisposed to disease . . . and if these teeth be extracted at any period before the age of twelve years, all the anterior teeth will grow more or less backwards and the second and third molars so move toward the anterior part of the mouth . . . to fill up the vacant space."

#### AMERICAN ORTHODONTICS, 1800 to 1840

Irregularity of the teeth had been recognized by dental surgeons early in the nineteenth century. Benjamin James (1814) noted that he was "often called upon to cure irregularity, than to prevent it."<sup>14</sup> Levi S. Parmly (1819) stated that "where irregularities are allowed to proceed and become fixed, it is often a matter of difficulty, and sometimes of impossibility to rectify them."<sup>14</sup>

Samuel S. Fitch, MD, whose book entitled *A System of Dental Surgery*, published in 1829, is considered the

first definitive work on dentistry in this country, devoted a significant amount of information to irregularities of the teeth. He was the first to classify malocclusion:

There are four states of this kind of irregularity. The first when one central incisor is turned in, and the under teeth come before it, whilst the other central incisor keeps its proper place, standing before the under teeth. The second is, when both the central incisors are turned in, and go behind the under teeth: but the lateral incisors are placed properly and stand out before the under teeth. The third variety is when the central incisors are placed properly but the lateral incisors stand very much in; and when the mouth is shut, the under teeth project before them and keep them backward. The fourth is, when all incisors of the upper are turned in, and those of the under jaw shut before them.<sup>14</sup>

His treatment consisted of applying "a force which shall act constantly upon the irregular teeth and bring them forward; the other force to remove that obstruction which the under teeth by coming before the upper, always occasion." This is done by "application of an instrument adapted to the arch of the mouth . . . fastening a ligature on the irregular tooth and . . . removing the resistance of the under teeth by placing some intervening substances between the teeth of the upper and under jaw, so as to prevent them from completely closing."

Other practitioners found various forms of treatment, such as the use of gold or silver plates "to exert a gentle but continued pressure." Shearjashub Spooner (1809 to 1859) wrote in his *Guide to Sound Teeth* (1838):

. . . we have to consider, first, their general appearance as to regularity to the central circle; and, second, the state of preservation of each individual tooth . . . in cases where there is a predisposition to a projecting chin. . . .<sup>1</sup>

M. Bourand from Paris observed that the parents should be alerted to the shedding of the deciduous teeth and any possible deformity. He stated:

Defects, sometimes, which are of such magnitude, that I have known, in my long practice in both hemispheres, some young ladies of respectable families and of elegant features who could not observe their smiling countenances in a looking glass without blushing at the irregularities of their teeth; when comparing their mouths with some of their young friends toward whom their parents had bestowed all the necessary care to regulate their growth from childhood.<sup>15</sup>

#### AMERICAN ORTHODONTICS, 1840 to 1875

The correction of irregularities, however, easy in theory, will be found most difficult and delicate in practice; not only will much skill be found requisite, but, in equal degree, patience.

*Robert Augustine, 1854*

Thus, by the mid-nineteenth century basic concepts of diagnosis and treatment had begun. It was a time when each practitioner attempted treatment by devising his own method based on purely mechanical principles. Orthodontics was part of prosthetic dentistry, and the literature on the subject described orthodontics in the area of partial and total replacement of missing teeth.

Chapin A. Harris (1806 to 1860), one of the most influential dental surgeons during this period, published the first modern classic book on dentistry, *The Dental Art*, in 1840. In it he gives much attention to various orthodontic treatment procedures that were adapted from French and English practitioners; his personal technique included the use of gold caps on molars to open the bite and knobs soldered to a band for tooth rotations.<sup>1</sup>

Materials generally used were cotton or silk ligatures, metallic wedged arches, and wooden wedges, but the discovery of vulcanite—a material used for artificial dentures—permitted the construction of bite plates and other forms of removable appliances. In addition, springs that were to be attached to the metal frames for use in individual tooth movement were introduced. As early as 1841, William Lintott introduced the use of screws. They were described in *On the Teeth*, in the chapter entitled "Irregularities of the Teeth":

When any one or more teeth project beyond the right line, and it is desired to move them inwards, a small hole must be drilled through the bar, over against the most prominent point of each; a screw-thread is then to be cut and a short screw introduced, which working through the bar, will, by a turn or two each day, keep up such a continued pressure against each tooth as will quickly force it back as desired.<sup>1</sup>

He described the premature loss of deciduous teeth as a cause of malocclusion, explained that crowding was due to faulty growth and development, recommended that treatment begin at the age of 14 or 15 years and also described a bite-opening appliance, which consisted of a labial arch of a light bar of gold or silver passed around the front surfaces of the teeth by means of ligatures (known as *Indian twist*), and the necks of the irregular teeth with pressure applied for movement.

In this manner, any required movement of the teeth, inwards or outwards may be affected with great ease, and in very little time causing no serious annoyance to the patient, the whole apparatus being removed and cleansed every two or three days.<sup>1</sup>

A modification of the screw, called *the crib*, was introduced by the Frenchman J. M. A. Strange in 1841. Strange also introduced the use of the clamp band and for retention advised: "I use a rubber band attached to some hooks on the appliance surrounding the molars

for retention."<sup>14</sup> The chin strap as occipital anchorage for the treatment of mandibular protrusion was introduced by J. S. Gunnell in 1840, and the principle of this may be seen today.<sup>16</sup> Occipital anchorage was obtained by the use of headgear devised by F. Christopher Kneisel.<sup>1</sup>

In 1852 the American Society of Dental Surgeons, the first national dental association established in this country (1840), committed to a great interest in this phase of dentistry, formed a committee on dental irregularities. The first report was given by E. J. Tucker, a respected dental surgeon of Boston, in 1853.<sup>17</sup> He condemned the practice of early extraction of deciduous teeth and advocated the use of rubber bands, or tubes, for tooth movement. He said, "The exact position of the teeth, the lines of force to be observed and the tenacity of the power exerted, are all considerations requiring study and a careful judgment."<sup>18</sup> This same Society sponsored the publication of the first book on orthodontics, *Essay on Regulating the Teeth* (1841). It was written by Solymon Brown (1790 to 1876) of New York and was intended to inform parents by stressing the importance of preventing irregularities.<sup>1</sup>

In 1854 Thomas W. Evans (1823 to 1897), an American dentist practicing in Paris, France, published the requirements for an appliance in the *Dental Newsletter*<sup>19</sup>:

- 1st: a firm support which shall not loosen or in any way injure the teeth to which it is attached;
- 2nd: a steady and sufficient pressure;
- 3rd: great delicacy of construction that the apparatus may be a light as possible;
- 4th: as a mechanism as simple as the case will admit.

In 1860 Emerson C. Angell (1823 to 1903) was probably the first person to advocate the opening of the median suture to provide space in the maxillary arch, since he took a strong stand against extraction.<sup>20</sup> James D. White also perfected a removable vulcanite appliance with a hinge in a split palate (1860).<sup>21</sup>

O. A. Marvin (1828 to 1907), in 1866, outlined the objectives of orthodontic treatment:

- 1st: the preservation of correct facial expression;
- 2nd: the restoration of such expression;
- 3rd: the proper articulation of the teeth for better mastication;
- 4th: their orderly arrangement, with a view to preventing decay.<sup>1</sup>

As early as 1871 William E. Magill (1825 to 1896) had cemented bands on the teeth.<sup>22</sup>

It may be of interest to know that in 1864 George J. Underwood<sup>23</sup> of New York presented his graduation thesis at the Pennsylvania College of Dental Surgery (Philadelphia) entitled "Orthodontia."

### AMERICAN ORTHODONTICS, 1875 to 1900

It was not until the latter part of the nineteenth century when a few dedicated dentists gave special attention and importance to this phase of dentistry, that our specialty began to emerge. Known in that time as orthodontia, it required special mechanical skills and knowledge in such basic sciences as anatomy, physiology, and pathology.

The period of the last three decades of the nineteenth century is studied in the framework of individual dentists and their contributions. Each practitioner developed his own theory and practice, some to a greater degree of excellence than others. Those to be discussed briefly include John H. Farrar (1839 to 1913); Norman W. Kingsley (1829 to 1913); Alton H. Thompson (1849 to 1914); Isaac B. Davenport (1854 to 1922); Henry A. Baker (1848 to 1934); Eugene S. Talbot (1847 to 1925); Simeon H. Guilford (1841 to 1919); and W. G. A. Bonwill (1833 to 1899).

John Farrar could be referred to as the *Father of American Orthodontics*. It was he who gave impetus to the scientific investigations that permitted the understanding of the theory and practice of orthodontics. He began his studies in 1875, during which time he investigated the physiologic and pathologic changes occurring in animals as the result of orthodontically induced tooth movement. As a result of his studies, he published a series of articles between 1881 and 1887 in the *Dental Cosmos*, one of the leading dental journals, enunciating the principle that "in regulating teeth, the traction must be intermittent and must not exceed certain fixed limits."<sup>24</sup> He also published *Irregularities of the Teeth and Their Correction*, Vol. 1 in 1888 and Vol. 2 in 1889, in which he demonstrated the many uses of the screw as the motivating attachment and the basis of what he referred to as a *system of orthodontia*. (Copies of these books are in the American Association of Orthodontists library in St. Louis, Mo.) (The jack-screw was originally introduced in 1849 by D. William Dwinelle.<sup>24</sup>) He stressed the "importance of the observance of the physiologic law which governs tissues, during movement of the teeth, the subject being to prevent pain."<sup>25</sup> Farrar was the originator of the theory of intermittent force, and the first person to recommend root or bodily movement of the teeth.

Norman W. Kingsley was a prominent dentist, artist, and orthodontist. As early as 1866, he experimented with appliances for the correction of cleft palate and is associated with a technique known as *jumping the bite* with the use of a bite plate.<sup>25</sup> It was the treatment for protrusion of the maxilla, not necessarily with extractions, shaping the dental arches to be in harmony with

each other. He used vulcanite in conjunction with ligatures, elastic bands made of rubber, jackscrews, and the chincap. In 1880 he published *A Treatise on Oral Deformities*, which remained a textbook for many years. He, too, emphasized the importance of the relationship between mechanics and biology as the principle on which orthodontics should be based. His book was the first to recommend that etiology, diagnosis, and treatment planning were the acceptable bases of practice. "Much success in treating irregularities will depend upon a correct diagnosis and prognosis."<sup>26,27</sup>

Alton H. Thompson was one of those forgotten dentists who made a valuable contribution to the specialty. He was recognized as an authority on comparative dental anatomy—certainly a basic consideration for orthodontists. (He was a founder of the American Anthropological Society.) He devoted himself to research into the dynamics of occlusion. This led him to the following analysis:

- (a) the construction of the temporomaxillary articulation allows for lateral anteroposterior, vertical, and oblique movements;
- (b) the extent of maxillary development is reflected for the necessary support of the extensive masticating mechanism;
- (c) there is a suppression of density and diameter of the maxillary bones;
- (d) there is a predominance of the rotatory over the elevating muscles of mastication; and
- (e) the special construction of the masticatory armature—this is the teeth, their vertices, parallel arrangement of the dental tissues, and the apposition of the crushing teeth.<sup>28</sup>

Isaac B. Davenport, as early as 1881, had created an interest in the study of occlusion. He developed a theory that the masticatory apparatus was subject to the laws of nature, that imperfect occlusion was deleterious to the dentition, that extraction of teeth in treatment could affect the efficiency of the masticatory apparatus. He lectured before the New York Academy of Medicine in 1887. His lecture entitled "The Significance of the Natural Form and Arrangement of the Dental Arches, With a Consideration of the Changes Which Occur as a Result of Their Artificial Derangement by Filing or by the Extraction of Teeth" was a tremendous influence on the orthodontists. To provide a normal occlusion the practice of extraction of teeth was almost abandoned, being replaced by the expansion of the arch and the realignment of the teeth.

While admitting the value of extraction as a means of correction of certain irregularities of the teeth, I am forced to

believe that far more irregularities have been caused by extractions than could ever have been corrected by extraction.<sup>29</sup>

Henry A. Baker is remembered because in 1893 he introduced the so-called Baker anchorage, or the use of intermaxillary elastics with rubber bands. The introduction of intermaxillary elastics was interpreted by some practitioners to mean the elimination of the need for extraction. Clark Goddard was an early advocate of the study and research into comparative odontology, the study of skulls and teeth.<sup>30</sup> This led to the acceptance of an expansion screw for the forcible separation of the maxilla. He also attempted to classify malocclusion, which included 15 separate types of irregularities.

Eugene S. Talbot was equally proficient in periodontics and orthodontics. He stressed the study of the causes of malocclusion to be the key to treatment. He stated that "without the etiology of irregularities no one can successfully correct deformities, as is evident in the many failures by men who profess to make this a specialty." He added, "Eighteen years of experience in the correction of irregularities of the teeth and a practical knowledge of the laws of mechanics have taught me not to rely on any particular appliance. Frequently, though a certain appliance has worked well in one case it may not have been efficient in another case of similar nature . . ." He advised close attention to disproportion in the size of the maxilla and mandible, "general contour and profile of the face," and "the family history including hereditary factors." He was one of the first to recommend the surgical exposure of impacted canines.<sup>31</sup>

In a paper presented to the Mississippi Valley Association of Dental Surgeons in March, 1891, entitled "Scientific Investigation of the Cranium and Jaws," he demonstrated intraoral measurements on casts with such instruments as the registering calipers and the T-square with graduated sliding indicator. This was one of the earliest attempts applying specific analysis of casts that reflected measurements of the jaws.

Simeon H. Guilford, dean of the Philadelphia Dental College, was regarded as one of the finest practitioners of that period. At the request of the National Association of Dental Faculties, he wrote the first textbook for students, *Orthodontia: Malposition of Human Teeth, Its Prevention and Remedy*, published in 1889. In it he attempted to offer a classification of malocclusion (p. 142):

There are two divisions—simple irregularities or the malposition of few teeth with no important facial disharmony and complex irregularities, that is, malposition of many teeth having corresponding facial deformity. (These divisions contain eleven classes of malposition.)

He commented on extraction in treatments:

Probably no operation in the practice of orthodontia is more important, or has associated with it greater possibilities for good or evil to the patient than that of extraction.

W. G. A. Bonwill said, "in vying with nature in matching the teeth, there must be more than mere mechanics, more than being capable of filling a tooth or treating an abscess—we must be dental artists." He developed what is known as the Bonwill equilateral triangle.<sup>1</sup> It is based on the mandibular analysis of a tripod arrangement extending from the center of the condyloid process to the median line at the point where the mandibular central incisors touch at the cutting edge. His measurements of more than 2000 cases showed that from the center of one condyloid process to the center of the other was 4 inches and that from the center to the incisor was also 4 inches. He used this theory in his orthodontic treatment. He advocated a specialty of orthodontics many years before Angle:

Really, in every city someone should make of this a special practice, and the profession should encourage such by sending cases for inspection and consultation. And such a specialist should do all he can in return to teach by example and demonstrations by clinics, to enlighten those who are placed so far from large cities that they are compelled to take such cases. When we can have that understanding between us, then we may feel as banded brothers more fully equipped for those hitherto difficult and thankless operations.<sup>1</sup>

The principles of resorption and deposition of alveolar bone during tooth movement were discussed by L. E. Custer (Ohio) in March, 1888, at a meeting of the Mississippi Valley Dental Association in a paper entitled "Intermittent Pressure: Its Relation to Orthodontia."<sup>1</sup>

In 1899 the *Items of Interest* was the first dental journal to devote a section of each issue to orthodontia because of the recommendation of its editor, R. Ottolengui (1861 to 1937).<sup>4</sup>

*This article will be continued in the next issue. The list of references will be furnished at that time.*



# A brief history of orthodontics

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## AMERICAN ORTHODONTICS, 1900 TO 1910

The most dominant, dynamic, and influential figure in the specialty of orthodontics was Edward H. Angle (1855-1930). He is regarded as the "Father of Modern Orthodontics." Through his leadership, orthodontics was separated from the other branches of dentistry (e.g., crown and bridge, prosthetics), and the result was the specialty of orthodontics. Angle was the first to limit his practice to orthodontics.<sup>32</sup>

In 1878 Angle received his DDS degree from the Pennsylvania College of Dental Surgery, and in 1887 he was appointed to the chair of orthodontia in the Dental Department of the University of Minnesota. He read his "revolutionary ideas" at the ninth International Medical Congress (District of Columbia), which received wide attention. The paper was entitled "Notes on Orthodontia With a New System of Regulation and Retention."<sup>34</sup> It was later published in the *Ohio Journal of Dental Science* (1887).

In 1888, during a lecture to the Iowa State Dental Society on his "system of orthodontia," Angle demonstrated for the first time the expansion arch and its auxiliaries. In 1894 he was appointed the first professor of orthodontia at Marian Sims College, receiving the MD degree from that college the following year. He declared:

Not until orthodontia is studied and practiced as a distinct branch of dentistry will it ever obtain success. There should be specialists in orthodontia and the general practitioner should send to the specialist freely.

His classification of malocclusion was published in the *Dental Cosmos* in 1899. The next year, having commenced informal instruction in his office, he organized the first school of orthodontia—The Angle School of Orthodontia. He placed the following advertisement:

For the fitting of teachers and specialists in orthodontia. Two short sessions are held each year, beginning November 1 and

May 1. Postgraduates in dentistry and only those thoroughly ethical, received. Class limited to fifteen members. For information, address Edward H. Angle, MD, DDS, 1107 North Grand Ave., St. Louis, Mo.<sup>33</sup>

Angle stated that "the idea of a postgraduate school was forced upon me because I wished to see those who had a desire to study orthodontia better receive the opportunity to do so." The course of instruction included art (taught by artist Edmund Wuerpel), rhinology, embryology, histology, comparative anatomy, and dental anatomy, in addition to his appliances. In 1907 Angle started a school in New York City, and then, from 1908 to 1911, his school was in New London, Conn., where 6-week sessions were offered at a tuition of \$200. In 1916 Angle moved again, this time to Pasadena, Calif., for reasons of health. From 1924 to 1927, his course was extended for 1 year.

In 1911 he declared:

Indeed, experience has proved that the degree of our success in the treatment of cases of malocclusion depends largely on the degree to which nature can be induced to complete the development of the underdeveloped bone, and the measure of this bone development depends greatly upon the age and vigor of the patient. In other words, the work of the orthodontist should be the intelligent assisting of nature in her process of developing bone, thus making it possible for her to normally build the denture in its entirety.<sup>34</sup>

Angle had an uncompromising position against extraction. It was his credo that "the best balance, the best harmony, the best proportions of the mouth in its relation to the other features require that there shall be a full complement of teeth, and that each tooth shall be made to occupy its normal position—i.e., normal occlusion."<sup>1,30</sup> Angle developed a classification of malocclusion based on this principle, which is still used today. He was an expert technician, a dynamic teacher, and a prime mover in making it known to dentists that orthodontics was a specialty of dentistry.<sup>1</sup>

Another distinguished orthodontist was Calvin S. Case (1847-1923). He was a graduate of Ohio College

of Dental Surgery and the University of Michigan Medical School. By 1890 he began the practice of general dentistry in Chicago with special attention given to crown and bridge. Case was recognized for his skill and artistry in the esthetic aspects of the practice. In the same year he was appointed professor of Prosthetic Dentistry and Orthodontia at the Chicago College of Dental Surgery.

Case continued his interest in orthodontics, devising original appliances and the use of intermaxillary elastics (a technique for which both he and Baker were to claim originality). His special attention to the cleft palate patient was a pioneering work, and he developed a classification of malocclusion that included 26 divisions. It was his reintroduction of the concept that the removal of certain teeth will enable the correction of malocclusion and improve general health and comfort that proved to be a "bombshell." It met with great opposition from many practitioners, especially those influenced by Angle.<sup>4</sup> In 1921 Case published his major work, *A Practical Treatise on the Technics and Principle of Dental Orthopedics and Prosthetic Correction of the Cleft Palate*.

Case was a strong advocate of the relationship of malocclusion to facial improvement. Facial improvement was a guide to treatment.

#### CASE/ANGLE CONTROVERSY

Originally, Case was a genuine admirer of Angle. He advocated the Angle system at every turn and hoped to place this system before the dental profession. In fact, he gave up the general practice of dentistry because of Angle's influence. The discord started over the claim that Angle attributed the origin of the use of intermaxillary elastics to Baker, while Case thought that he should have received that credit. In fact, when Angle described this procedure, he never mentioned Case. This led to charges and countercharges between them in 1903. Case's claim was that in 1890 he started this procedure and reported it at the Chicago Dental Society and also at the Columbian Dental Congress in 1893.

The second point of contention was—and is the one usually remembered—the question of the extraction of certain teeth as a means of treatment. Angle's thesis was that "there shall be a full complement of teeth, and that each tooth shall be made to occupy its normal position." Case defended the discreet use of extraction as a practical procedure, while Angle believed in nonextraction. However, the unexpected result of this controversy was that it convinced general prac-

tioners that they should not attempt orthodontic treatment but should refer patients to the specialist.<sup>35</sup>

The extraction story was continued into 1911 with Martin Dewey (1881-1933) an ardent champion of non-extraction. Dewey served as professor of Orthodontics at Kansas City Dental School, the University of Iowa Dental Department, the Chicago Dental College, and the New York College of Dentistry. He gained a wide reputation as an outstanding teacher. He had started his own graduate school in orthodontics in 1911 as the Kansas City School of Orthodontia and continued it as he traveled from one city to another, ending in New York City with his death in 1933. His influence was much felt since he was the editor of the *INTERNATIONAL JOURNAL OF ORTHODONTIA* for 17 years and also the president of the American Dental Association in 1931.<sup>36</sup>

The climax of this conflict was a debate in 1911 at the annual meeting of the National Dental Association (former name of the ADA). Bitterness and animosity were rampant. It took many years after this episode for the problem to become a matter of calm and objective evaluation and respectful appreciation of various points of view, each of which has made its contribution to orthodontics.

The first decade of the twentieth century was an era of the manufacture of standardized appliances. These appliances were made as sets of various kinds mounted on cards and sold by dental supply companies. By the use of a few simple soldering techniques, the dentist could make a required "fitting," as it was called.

William J. Brady (Iowa City) advertised as a consulting specialist in orthodontia:

Advice by mail upon regulating cases of all kinds. Appliances fitted to models with full instructions for handling from beginning to end. Instructions: send good models of both upper and lower, with thin wax bite. Give age and sex. Pack carefully. After examination, an estimate of the cost of instructions of appliance will be submitted free of charge. If satisfactory, remit the amount by bank draft or money order.

George C. Ainsworth patented a regulating appliance that used vertical tubes and the principle of the loop wire in 1904.<sup>37</sup> Varney Barnes patented the so-called Barnes posterior tube consisting of a soldered band that held several teeth together, with vertical tubing applying root pressure to individual teeth.<sup>31</sup>

Many innovative ideas and procedures were introduced. Victor H. Jackson (1850-1929) was experienced in mechanics and devised a specially designed appliance known as the Jackson crib, which incorporated the use

of an auxiliary spring (finger) as an aid in tooth movement.<sup>38</sup> His appliance was one of the first "systems" of treatment to influence the development of modern orthodontics. Jackson published *Orthodontia and Orthopaedia of the Face* in 1904. In it he claimed that with his method a large number of patients could be cared for as contrasted to the highly sophisticated techniques in vogue at the time that limited the number of patients.

Another contribution was reintroduction of the maxillary suture opening by Herbert A. Pullen (1874-1938) in 1902.<sup>39,40</sup> Charles A. Hawley (1861-1929) used a celluloid sheet containing a geometric figure that, when adapted to a model, determined the extent of proposed tooth movement (1905)<sup>41</sup> and introduced the retainer appliance that bears his name (1908).<sup>40</sup>

Scientific studies included research in dental histology, particularly by Frederick B. Noyes (1904);<sup>42</sup> the influence of heredity and environment on dental structures (1905);<sup>43</sup> emphasis on rhinology, which brought the medical fraternity into cooperation (1907);<sup>40,44</sup> the study of the deciduous dentition vis-a-vis nasodental growth, especially by Edward A. Bogue (1838-1921);<sup>45</sup> and the diagnosis of "mouth breathing," which took on special meaning (1907).<sup>30</sup>

In 1907 Benno Lischer (1876-1959), dean and professor of dental orthopedics at Washington University Dental School in St. Louis, founded the International School of Orthodontia, and in 1912 he published *Principles and Methods of Orthodontia*. He was an advocate of early treatment. Lischer wrote: "It is my firm belief that irreparable damage is done by oft repeated advice to wait until the permanent teeth are all erupted before beginning operations for correction of malocclusion."<sup>46</sup>

Other publications included the first separate journal entitled *American Orthodontist*, which started in 1907 and ceased publication in 1912. In 1909 C. N. Johnson (Chicago) edited a work entitled *A Textbook of Operative Dentistry*, which contained a chapter, "Orthodontia," written by Herbert A. Pullen covering over 275 pages of text. It contained not only etiology, diagnosis, and treatment modalities but also instruction in laboratory procedures.

#### AMERICAN ORTHODONTICS, 1910 TO 1920

The second decade of this century is noted for several important advancements, namely, the serious study of tissue changes during orthodontic tooth movement by Albin Oppenheim (1911)<sup>38</sup> and the beginning of a major interest in diet, nutrition, and genetics as reflected in orthodontic diagnosis.<sup>47</sup> Moreover, Alfred Rogers (1873-1959) introduced the concept of myofunctional

therapy (1918).<sup>48</sup> John V. Mershon (1867-1953) introduced the removable lingual arch based on the principle that teeth must be free and unrestricted for adaptation to normal growth.<sup>49</sup> Albert H. Ketcham (1870-1935), a devoted researcher, was one of the first to introduce the roentgenogram and photography into orthodontic practice.<sup>48</sup> He was a great humanitarian and, as early as 1910, established an orthodontic clinic at the Children's Hospital in Denver. He was regarded as a leader in orthodontics in the West and in his memory the American Association of Orthodontists has established the Ketcham Award to be given annually to a member in recognition of outstanding contributions to the specialty. A. LeRoy Johnson (1881-?) reemphasized the biologic concept in orthodontics: "The form of structure is the result of an interaction of function and structure, and that in the ultimate function is the determining factor in form development."<sup>50</sup> It was the individuality of the norm that was paramount.

One of the outstanding scientific figures of this period was Milo Hellman (1873-1947). Since 1912 he had turned his attention to research in the science of anthropology and its relation to the growth and development of the human dentofacial complex. Hellman sought an explanation of the development of human dental occlusion, linking the phenomenon of occlusion with the evolution of the dentition as a whole. He introduced craniometric measurements and a classification of dental development (1935).<sup>51,52</sup> His philosophy of orthodontics was based on the biologic concept and held that it was through the scientific method that the problems of orthodontics would be solved. Hellman's motto was "perfection is the goal, adequacy is the standard" (Personal interview with W. H. Krogman). He seemed to embody the plea of Eugene Talbot, who wrote in 1890: "There is now a demand for more breadth of scientific culture, and more comprehensive knowledge without which good judgment is impossible."

The INTERNATIONAL JOURNAL OF ORTHODONTIA AND ORAL SURGERY was started in 1915. This year is its diamond jubilee year.

#### AMERICAN ORTHODONTICS, 1920 TO 1930

The decade of the 20s was noted for the introduction of several new appliances, such as the George Crozat removable with springs (1928),<sup>53</sup> the open tube of James D. McCoy (1922),<sup>54</sup> and the universal by Spencer P. Atkinson—the appliance that was a combination of the ribbon arch appliance and the edgewise appliance. There was the introduction of stainless steel to appliance fabrication by the Belgian, Lucien de Coster (he was

the editor of *Archives of Orthodontics*). Research studies included orthodontic metallurgy, particularly by the metallurgist R. W. Williams; Paul Simon's (1883-1957) studies of facial bones that introduced the orbital-canine rule, gnathostatics (1924)<sup>55</sup>; the research of the apical base by Alex Lundström (Sweden) that made an impact in this country<sup>56</sup>; and the studies of root resorption by Albert H. Ketcham.

Under the guidance of Albert H. Ketcham, the American Board of Orthodontics was created in 1929 and incorporated in 1930.

#### AMERICAN ORTHODONTICS, 1930 TO 1940

In 1931 B. Holly Broadbent published an article in the first issue of the new *Angle Orthodontist* entitled "A New X-ray Technique and Its Application to Orthodontia." It was the introduction to the specialty and to dentistry of cephalometric roentgenography and, of course, cephalometric tracing and evaluation.

Broadbent devised the roentgenographic cephalometer, which is the instrument that accurately positions the head relative to the film and x-ray source. His study, supported by the Bolton family, consisted of a longitudinal study of 3500 schoolchildren from birth to adulthood. In honor of his sponsor, Broadbent established a new point of reference on the skull, known as the Bolton point.

It was during 1940 that Oren A. Oliver (1887-1965) introduced the labial arch in conjunction with the lingual and thus establishing the labiolingual appliance. Robert R. W. Strang (1881-1982) founded a postgraduate school in Connecticut and was a strong influence on the specialty for many years. His book, *A Textbook of Orthodontia* (1933), was widely used and became a guide to the "Strang technique."<sup>57</sup> The French orthodontist, Pierre Robin, had developed a new concept in 1902<sup>58</sup>—the activator or monobloc. It was reintroduced in 1932 by the Swedish orthodontist, V. Anderson, and was based on the concept that the musculature has a determining effect on growth of the dental apparatus.<sup>59,60</sup>

In 1938 Joseph Johnson (1888-1969) introduced the twin-arch appliance in which the resiliency of the double wires would be the key factor; that is, the use of these thin-gauge wires provided the gentle force for tooth movement.<sup>61</sup>

Starting in 1936, the *Yearbook of Dentistry* was published annually. It contained articles from several branches of dentistry, especially on orthodontics, and was edited by such prominent orthodontists as George R. Moore and George M. Anderson (1897-1983). It is

of interest to note that such topics as adult orthodontics, orthognathic surgery, and early extraction of the permanent first molars were fully discussed in these pages by the mid-1940s.

By the end of the decade, the public was beginning to be aware of the benefits of orthodontic treatment. It was a time when socialization of medicine and dentistry threatened. Dentistry fought for continuation of the private practitioner system. Clinics for profit were organized with the concept of prepayment plans. Compulsory health insurance was continuously being thrust on the public consciousness. However, the introduction of orthodontic health care programs did not enter the picture until the 1950s.

#### AMERICAN ORTHODONTICS, 1940 TO 1950

The next decade saw the greatest impetus to research activity. Numbered among the outstanding contributors were Wilton M. Krogman (1903-1987) who, applying the principles of physical anthropology to the dentofacial complex with craniometry and roentgenographic cephalometry, brought to orthodontics a set of criteria for growth and development of the child and adolescent that set the standard for all future research. Although not an orthodontist, Krogman's contributions to the study of the human being from birth to maturity have had a continuing positive effect on the establishment of a scientific base for the specialty. His publications have become classics in the field, earning him a worldwide reputation. In his honor the facility in Philadelphia where he worked for many years has been named the Krogman Center for Research in Child Growth and Development.<sup>62</sup> Allan G. Brodie also contributed to the study of the growth patterns of the human head from the third month of life to the eighth year. His research was published in the *American Journal of Anatomy* in 1941.<sup>63</sup>

In the same year, Charles H. Tweed (1895-1970) introduced into the literature an "edgewise" appliance, based on the basal bone concept. His method of treatment discarded the first molars as the key units in corrective procedures. Tweed's primary efforts were concerned with the movement of the mandibular incisors to the extent necessary to relocate them on the basal ridge of bone arising from the symphysis of the mandible, giving support to the alveolar process. Once positioned, these teeth become the governing factors for the determination of the location of both maxillary and mandibular arches.<sup>30</sup> His original work may be found in Volume 2 of the *Angle Orthodontist*. Tweed was also a strong advocate of "good facial esthetics."

