The dawn of rapid maxillary expansion

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Abstract: The first report of lateral maxillary expansion by separation of the maxilla, written by Angell and published in 1860, was discredited. Applying our present-day knowledge of the technique to the original documents indicates that the case history agrees in general with current observations. The arguments mounted against Angell, especially by McQuillen, may be dismissed as irrelevant and Angell's thesis is upheld. In addition, good reason exists to accept three further "firsts" in this unprecedented work: (1) The significance of the first permanent molars in occlusal development, (2) the use of a double-action jackscrew, and (3) the use of a retention plate.

Key Words: Rapid maxillary expansion

In the extensive bibliography of lateral maxillary expansion with midpalatal suture opening, often referred to as rapid maxillary expansion (RME) or rapid palatal expansion (RPE), the earliest commonly cited report is that of E.C. Angell[1] (*Dental Cosmos* mistakenly printed his second initial as *H*), published in the *Dental Cosmos* in 1860. The work was discredited at the time, but the technique is now generally accepted as a relatively simple and predictable orthodontic therapy. Weinberger[2] recorded it in his engrossing review of orthodontics, but to this writer's knowledge, the case has never been examined from a critical clinical standpoint.

The purpose of this report was to sift through the available documents for hard evidence of the assertions made and, with the benefit of hindsight, seek a true conclusion to that contentious event.

Emerson Colon Angell (1822-1903, Figure 1) was a seventh-generation Rhode Islander who grew up in the township of Scituate. His father, a farmer, lawyer, and justice of the peace, schooled him in agriculture and mechanics. That early mechanical training stood him in good stead when, following a short spell as a teacher,[3] he began studying dentistry in 1846. In the absence of formal tuition leading to a university degree, some preceptor instruction may be assumed. His publications show him to be a good writer, and the range of references attests to his scholarship. By all appearances, he took his chosen profession seriously.

From the directories of the day, we can plot his working life, first in Providence and Woonsocket, RI, then New York City, and finally San Francisco. By 1860 his dental practice was firmly established in a prestigiously sited office at the corner of Clay and Kearny streets, overlooking the Plaza. A bungalow on Folsom Street served as his private residence. These moves suggest a person with ambition and an eye for better opportunities. Surely he was cast in the mold of the self-made American.

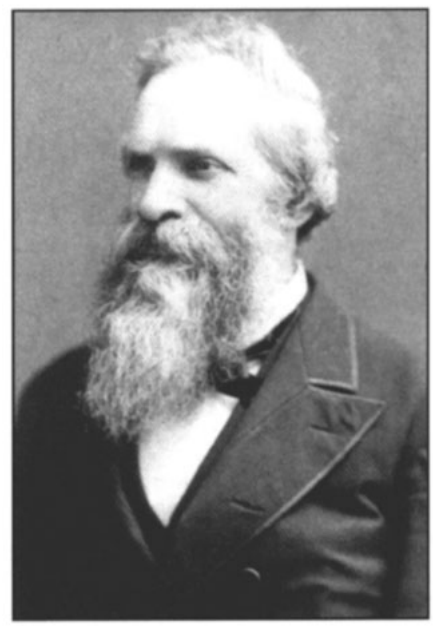

Figure 1
Emerson C. Angell, ca. 1880. Photo courtesy Trent C. Devenny.

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The original publications

The *Dental Cosmos* article was a slightly edited version of a paper that was first published in the fledgling *San Francisco Medical Press* (*SFMP*). The first issue of the *SFMP* appeared in January 1860, and featured an article by Angell[4] on the deciduous dentition. Evidently he intended a second article[5] (on the permanent teeth) to be a follow-up, and it was duly published in the *SFMP*. In his description of the development of the permanent teeth, Angell made a momentous statement regarding the timing and positioning of the first permanent molars:

> These teeth, four in number are the first to take up their positions in the mouth and are usually fully developed and admirably articulated before any of the primary teeth have fallen from their sockets. Nature in her munificent wisdom provided a sure and unerring guide to the correct occlusion of the jaws, despite the loss of the deciduous set.

The article included a brief case history of a patient with a crossbite who was treated by lateral maxillary expansion. That case report became the focus of attention and controversy, thanks to Angell's iconoclastic interpretation of the bony anatomical changes. The patient, a 14-year-old girl with ectopic left upper lateral and premolars, was fitted with a unique appliance that featured two contrarotating screws, threaded left and right (Figure 3). It was neither cemented nor cribbed, but relied instead on pressure from the screws to hold it in place against the necks of the teeth. The bearing surfaces were lined in soft gold so as not to damage the teeth. He gave the patient the following instructions: Keep the appliance as uniformly tight as possible by turning the screw.

Angell claimed that correction was achieved in 2 weeks by separation of the maxilla along the midpalatal suture. Unfortunately, he gave little other clinical information. He did report the appearance of a superior median diastema. Following expansion, the upper left premolars were moved distally to make room for the canine, and treatment was completed by fitting a retainer. In Angell's mind, this was a major accomplishment, worthy of a wide circulation within the dental profession. Proof copies of the *SFMP* article were sent to the widely read *Dental Cosmos*.

To Angell's chagrin, the arbiters of dental custom in Philadelphia (where *Dental Cosmos* was published) were to disagree, and the *Dental Cosmos* version of the article appeared under a withering disclaimer:

> We must beg leave to differ with the writer in the conclusion arrived at, that by the use of the apparatus described he succeeded in separating the superior maxillae from each other. With no disposition to assert that such a thing is *utterly impossible,* yet, when taking into consideration the anatomical relations existing between the right and left superior maxilla and the other bones of the face with which they articulate, such a result appears *exceedingly doubtful.*

These words are almost certainly the work of J. DeH. White (1815-1895), editor for original manuscripts, who had earlier presented a case of maxillary expansion.[6] In addition to this editorial criticism, the illustrated model was printed without the median diastema (Figure 3B). Angell believed the omission was done deliberately to undermine his claim of maxillary separation.

He fought back with another article in the *SFMP*[7] in which he provided more details of the case history in order to strengthen his claim. The transpalatal width, measured at the lingual surfaces of the first premolars, was given as ten and one-half lines before expansion and thirteen and one-half lines after. A line is an old-fashioned unit of measure equal to one-tenth inch, meaning Angell claimed an increase of 0.30 in.

Figure 2
Angell's office, in a building on the corner of Clay and Kearny streets, San Francisco. Illustration from an advertisement, San Francisco directory, 1857.

With the previously given treatment time of 2 weeks, we now have the rate of expansion, higher than that used by most clinicians today but certainly possible. Other disclosures included transient painless loosening of the central incisors (a common finding in modern cases) and heightened color of the palatal mucus membrane along the line of the suture (not generally recognized as hemorrhage due to the torn suture, but screws today are set close to the palate and irritation from the acrylic pads would heighten the color). Angell explained the spontaneous correction of the lateral trapped inside the bite by jaw opening as the cusps of the posteriors rode up the inclines of their antagonists, thus freeing it without recourse to capping. He asserted that the bony void created by the separation would spontaneously remineralize.

This follow-up article was published only in the *SFMP*. With its limited circulation, few dentists would have seen it. However, it was read by the *Dental Cosmos* board, who remained obdurate and countered with a review by J.H. McQuillen[8] (1826-1879), a highly respected dentist. McQuillen was medically qualified and later became president of the American Dental Association (1864-65). He opened his review by apologizing for the absence of the diastema

in the original figure, blaming the error on the poor quality of the proof copies *Dental Cosmos* received. Then, in a long tirade, he tried to demolish Angell's thesis by arguments that ranged from the specious to the fallacious. For example, he stated that if the maxillae had separated, the width of the diastema would likely be 3 lines and the maxillae would become loose.

Discussion

Dentists in the 19th century were facing up to the problems of malocclusion, and advances in biotechnology were providing the hardware they needed to meet many challenges. A search of the literature reveals published case reports of crossbite correction using slow expansion,[6,9-11] and it could be only a matter time before lateral maxillary expansion was achieved by opening the midpalatal suture. The necessary ingredients were a dentist with the requisite design skills and physioanatomic insight, a patient with a particular malocclusion, and—to this, the writer appends—a fair share of luck. Angell met these criteria. He was neither charlatan nor crackpot; indeed, his impeccable professionalism showed through in his description of the phenomena and his proposed interpretation. It would have been impossible to concoct such a set of circumstances given the dental knowledge at that time, and had he done so, it would have been a remarkable show of prescience, when even the academics of the day were unable to comprehend the reality.

McQuillen's argument about the maxillae becoming loose can easily be dismissed, but he is on firmer ground regarding the diastema not being 3 lines wide. However, we do not know at what stage the impression was taken, and the figure is only a drawing. Furthermore the artist made at least one mistake in delineating the screws, as they are both left-handed and could not possibly work in that configuration.

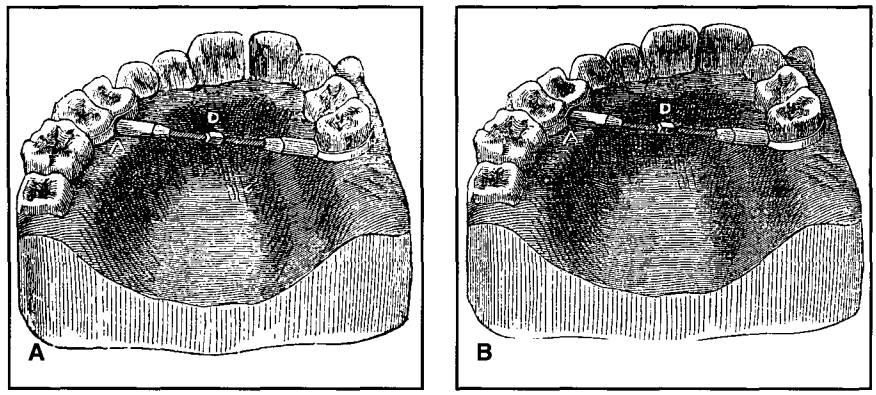

Figure 3A-B
Appliance on model after expansion (note incorrect drawing of the threads.
A. As published in *SFMP*, showing median diastema
B. As published in *DC*, without median diastema

However, some questions remain unanswered. Did Angell set out to expand the arch by opening the suture? Probably not, judging by the instructions to "keep the appliance as uniformly tight as possible by turning the screw." He must have said more to the patient than those 12 words, but we cannot know for sure. This should not, however, deprive him of the credit, as many great discoveries have been made by chance; the importance lies in the accuracy of his report and explanation. In light of this writer's clinical experience, Angell was probably lucky in the dental anatomy of his patient; an uncemented or uncribbed appliance is prone to dislodgement and most likely the undercuts had been favorable. The patient's age might also have helped, especially if there was some gingival recession. On the other hand, the microanatomy called for minute fractures in the suture line[12] and considerable force,[13] but that should have been within the capacity of the appliance. Frequent turns of the screw would have been necessary to keep up the pressure, which might account for the rapid expansion.

When all the pros and cons are thrown onto the balance of probability, it must come down heavily in favor of the midpalatal suture being opened. Lacking the ultimate test, namely X-rays (which were 35 years down the line), we cannot be 100% sure.

Looking back, the *Dental Cosmos'* criticism was a blessing in disguise in that it provoked Angell into publishing a more thorough case history of RME. Taking the two articles together,[5,7] we have a definitive statement containing four "firsts":

1. Lateral maxillary expansion by bony separation
2. Use of a jackscrew with contrarotating threads
3. Relevance of the first permanent molars in the development of the dentition
4. Use of a retention plate

Weinberger[2] recorded the first three items and placed Angell's contribution at the beginning of an era in orthodontics. Regarding the fourth, this writer is indebted to Dr. Henry Kaplan of Brookline, Mass.; the claim will stand until and unless an earlier account is found.

Unfortunately, those controlling the most influential dental journal of the day could not see past the limitations of the accepted science. Their shortcomings resonated across the Atlantic and, in 1865, Coleman[14] added his disapproval of the technique in an address to the Odontological Society of Great Britain. It's not the first time we have beheld such a scenario, and likely it won't be the last. The

Establishment's censure acted as a clinical moratorium, and 33 years of development and progress were lost before Prof. Clark Goddard[15] (1849-1905) published an accepted paper. This time it was conceived within a university campus, and the subject under discussion was a product of the marketplace.

Nothing more was heard from Angell on this topic. An illness forced him to leave San Francisco for treatment in New York and, upon his recovery, he turned to medicine, qualifying as a Doctor of Medicine from Bellevue Hospital Medical College in 1866. Suffice it to say that he applied himself to his new profession with similar ingenuity and tenacity, but that is another story.

Conclusion

There can be little doubt that Angell was the first to laterally expand the maxilla by bony separation. The evidence is also substantial for a primary claim to (1) use of a double-action jackscrew, (2) report the significance of the first permanent molars in the developing dentition, and (3) use a retention plate.

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