Was the destiny of orthodontics written in the stars?

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This fanciful tale describes an 1882 meeting in London between a young American dentist and 2 highly acclaimed English scientists. Although fictional, the story is historically accurate, and the ideas expressed are authentic. One participant in this colloquy is Edward H. Angle. He was a 27-year-old farm boy from rural Pennsylvania whose formal higher education consisted of 2 years at a proprietary dental college in Philadelphia, from which he graduated at age 23. The other participants are 73-year-old naturalist Charles Darwin and his cousin, 60-year-old Francis Galton, an anthropologist and statistician. Darwin and Galton grew up in highly educated and wealthy families and graduated from the University of Cambridge.

The following conversation ensued.

Darwin: So, young man, what are your professional interests?

Angle: The area of dentistry that interests me is the art and science of orthodontia. Until the publication of Norman Kingsley's *Treatise on Oral Deformities* 2 years ago, this subject received relatively little attention in the United States. I am fascinated by the problem of irregularities of the teeth and jaws and their effects on oral health and facial balance; however, what I really enjoy most is the design and construction of mechanical devices to regulate tooth positions.

Galton: My, you American chaps are keen on what in England today we call technology. We have been very impressed recently with Alexander Graham Bell and Thomas Edison. They are amazingly clever fellows. Are you more interested in the mechanical or biological aspect of tooth regulation?

Angle: I suppose both, although I must confess that I am an inveterate tinkerer and would love to be an inventor one day.

Darwin: Perhaps you will be another John Tomes, who is a friend of ours from the Royal Society of London. John performs orthodontia in his private dental rooms using removable plates and wires to apply forces to the teeth. He was also the first to elucidate the remodeling of alveolar bone during tooth movement. John was the driving force 2 years ago in gaining recognition for dentistry as a profession along with the establishment of the British Dental Society. Perhaps you will be able at some point to establish orthodontia as a dental specialty in America.

Angle: I am very flattered by your compliment; of course, I heard the name "Tomes" in our dental histology course in school. We learned about Tomes's processes in relation to amelogenesis.

Galton: Edward…

Angle: Sir, please call me Hart.

Galton: …what elements of science do you hope to bring to tooth regulation?

Angle: I would like to develop the science of occlusion.

Galton: Hart, I must confess that I don't know the term "occlusion" and thus can't understand what the science of occlusion is.

Angle: "Occlusion" is the term used in the States, which is supplanting the phrase "articulation of the teeth."

Darwin: So, dental occlusion is what the Scottish surgeon and anatomist John Hunter described nearly a century ago.

Angle: Yes, sir; however, William Gibson Arlington Bonwill, a well-known dentist in Philadelphia and one of my teachers in dental school, has devised a new method for describing ideal occlusion based on geometric principles. His "line of occlusion" serves as the basis for describing ideal occlusion, which he says is the magnificent plan of the "divine architect." Just as Bonwill has described ideal occlusion, I would like to one day develop a classification of what another Philadelphia dentist, Simeon H. Guilford, has been calling "malocclusion."

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Darwin: Although your man Bonwill appears to be quite an innovator, I don't think his concept is very scientific. His term "divine architect" sounds more like the words of a priest than a scientist. I'm also a bit suspect of the term "ideal occlusion." After many years of studying nature, I am struck by how great variation is in all of biology. I have not found anything perfect in nature. Thus, ideal occlusion doesn't seem to allow for any variation. This strikes me as very unnatural indeed. To my way of thinking, the observation that the teeth of modern man are becoming more irregular is an evolutionary trend because the jaws are getting smaller. I would highly recommend your reading my treatise, *The Origin of the Species by Means of Natural Selection.*

Galton: Hart, let's get back to what you were talking about before. What is Bonwill's hypothesis?

Angle: He believes ideally arranged teeth create better function and improved oral health.

Galton: This sounds like a reasonable hypothesis. How has Bonwill tested his theory?

Angle: I'm not sure I fully understand the question.

Galton: Does Bonwill have evidence to support his hypothesis? For instance, has he used biometric methods to measure identifiable traits of occlusion as well as quantifying the various functions and health of the mouth? Has he then subjected the data to statistical evaluation such as correlation or regression analysis?

Angle: I'm not familiar with these techniques, and I don't believe Bonwill is either.

Galton: Cousin Charles, do you have a stylographic pen and piece of paper so that I can show Hart what I mean? *(Galton draws a bell curve and describes the concepts of normal distribution, means, and standard deviations. He then draws a regression line and explains the difference between correlation and regression—a term and a concept he proposed some years before.)*

Angle: I see. This is fascinating!

Darwin: Hart, I am concerned by your use of the term "science" of occlusion. The important issue is that, until a hypothesis is tested and validated, it does not qualify as science. Some questions can be asked in scientific fashion but can't be answered scientifically. In those instances, it is called pseudo-science, and there are important differences between science and pseudo-science. The classic example of pseudo-science is astrology. Astrologers for at least 3000 years have believed that celestial observations like the positions of the stars correlate with terrestrial events. Although astrology has a number of traits in common with contemporary science, it doesn't fulfill the criteria of an actual science. For one, astrologers use conjecture rather than empirical data, and when subjected to testing with the scientific method, their hypothesis cannot be supported. I don't want to belabor this point, but it is possible that Bonwill has fallen into this trap, and your science of occlusion one day may be considered pseudo-science.

Galton: It is likely that Bonwill's geometric ideal—ie, line of occlusion when biometrically tested—will most likely represent a central tendency or mean. What must be determined is the variance or standard deviation. Surely, we know that dental arch forms can range from "V shaped" to "U shaped" and many different configurations in between. The first step for calculating arch form will be the easy part, although determining the best arch form for a person will undoubtedly be more difficult. Defining the functions of the teeth and jaws and the health of the mouth, and identifying measurable and quantifiable traits for each function, may prove to be a far more difficult problem, since you will no longer be dealing with morphology, but physiology. Ultimately, the most difficult task will be the determination of the etiology of these tooth and jaw irregularities. To what extent are these problems due to heredity or environment? I have called this "nature vs nurture." We have been performing twin studies using identical and fraternal twins to study this question regarding other physical traits.

Darwin: Hart, you spoke about the relationship of the teeth to the face. Did you know that this has been one of my interests in the past? I have studied facial expressions in animals and man. When you have time, you will enjoy reading my treatise on *Facial Expression in Animals and Man.* Smile has been one of the fascinating aspects of these studies. For instance, did you realize that we determine whether a smile expressing enjoyment is authentic by observing whether there is crinkling around the eyes more so than any configuration of the lips? Anterior tooth display during facial animation will be an interesting area of investigation in the future, and it certainly is germane to orthodontia.

Angle: I am embarrassed to say that I was thinking more about simply studying the facial profile rather than some of the other aspects of facial appearance you have described.

Galton: Cousin Charles, let's not diminish what we can learn from studying static facial profiles. In our anthropometry laboratory, we have analyzed soft-tissue profiles as part of our craniometry studies. On an image of the profile, we draw a line from the soft-tissue forehead to the soft-tissue chin as a reference line for assessing the positional relationship of the nose and lips. We have also been using composite frontal photographs to compare different facial types. We superimpose the photographs using the eyes as reference

points. This superimposition technique will certainly have other future applications.

Angle: What other advice might you have for me?

Darwin: It seems to me that you are implying that tooth irregularity is some type of malady or malformation. My view is that malocclusion, as you are calling it, is simply a normal heritable morphologic variation as a result of evolution. With your view, orthodontia could erroneously be considered "applied biology," since the ability to move teeth by way of continuous force application, as first described by Celsus and published in the 15th century, relies on a biologic principle. Nonetheless, this principle alone does not make orthodontia "applied biology." The future development of more and more elaborate and precise methods to move teeth into preconceived positions will not require the application of biology as much as it will need invention. Your goal of one day becoming an inventor seems to be appropriate.

Galton: Hart, we hope this discussion has been useful.

Angle: Gentleman, you have given me a tremendous amount to think about. I am truly honored to have met you both.

Darwin: It has been our pleasure.

Galton: All the best to you in your future endeavors. By virtue of your obvious intelligence and determined personality, you strike me as a young man with remarkable potential.

Charles Darwin died later in the same year that this imaginary conversation transpired. Although his theory of evolution was well accepted in Europe at the time, it took another 40 years before it was embraced in the United States. Even today, the creation-evolution controversy exists in many areas of this country. Arguably, the concept of evolution is one of the most important scientific achievements in the history of the life sciences.

Francis Galton lived for another 29 years. He was one of the most exceptional polymaths in the history of science. His contributions most germane to orthodontics involved the application of statistics to the anthropometric and psychometric measurements of the differences in humans.

Edward Angle lived for another 48 years, during which time orthodontics became the first recognized specialty of dentistry. During his lifetime, he earned the appellation "father of modern orthodontics." One of his crowning achievements by his own account was the invention and patenting of the edgewise appliance. Although there have been many modifications of this ingenious appliance over the last 86 years, it still exists largely as it was originally conceived by Angle.

In the last 100 years, no one has been able to produce scientific evidence to corroborate Bonwill and Angle's original hypothesis. Occlusion is no more a science today than it was in the 19th century. In spite of this flawed conceptual underpinning to orthodontics, ideal occlusion is likely to remain the most fundamental concept in orthodontics until a new and hopefully more scientific paradigm replaces it. Ideal occlusion has served as a highly useful arbitrary standard for judging the skills of orthodontists and is still the major tool used by the American Board of Orthodontics for ascertaining board qualification. Thus, it is fair to say that orthodontics has been more technologically driven than biologically or scientifically based.

Over the last half century, with the burgeoning of mass communication, the worldwide popularity of orthodontics has been greatly advanced by the advertising industry and the media. Their focus on facial beauty and "perfect smiles" as symbols of health and vitality have done more to promote orthodontics than any biologic or scientific discovery during this same period. In the 21st century, orthodontics is being swept along by cultural currents that have shaped the present age of medical and dental enhancement. How might orthodontics have evolved if Bonwill and Angle had been more broadly educated in the biologic sciences of their day? Ironically, to some extent, Angle's seeming lack of appreciation for inherent normal human morphologic variation led to his conceiving and developing the edgewise appliance.

As we honor the patriarchs of modern orthodontics, we await the arrival of a mother or father of a new and more scientifically valid paradigm for our specialty. Until then, we should unapologetically enjoy our success as highly skilled menders of fractured smiles and savor the well-earned gratitude of untold numbers of patients for their enhanced dentofacial appearance and increased sense of well-being.