Editorial

Fifty Years of Cephalometric Radiography

The fledgling ANGLE ORTHODONTIST was barely under way when the second issue published what has proven to be one of the most significant papers in orthodontic history — Broadbent's introduction of radiographic cephalometrics.

On this fiftieth anniversary of that event, the original article and three of Broadbent's best-known illustrations of growth changes in the face are reprinted for today's readers. This is followed by a detailed overview of the current state of the art of clinical application by Robert Ricketts.

Before Radiographic Cephalometry

Like virtually all advances in the healing arts, cephalometrics is based on older methods. Craniometrics was already being used to measure dried skulls, direct cephalometric measurement was being applied to external structures on the living, and radiography was an accepted clinical procedure. During the same period Pacini was also x-raying skulls in Europe.[1]

B. Holly Broadbent merged those very different techniques to measure all three dimensions of both internal and external structures of the heads of living subjects.

Broadbent's interest in craniofacial growth began with his orthodontic education under E. H. Angle in 1920. He continued to pursue that interest along with his orthodontic practice, working with T. Wingate Todd in the Anatomy Laboratory at Western Reserve University.

Todd was a leading anatomist with an abiding interest in the growth of the living. He was frustrated by studies limited to bones and cadavers, but those studies provided an invaluable foundation for future work by Broadbent as well as his own landmark radiographic atlas of the hand and wrist.[2]

During the 1920's Broadbent refined the craniostat that was used to orient skulls for measurement into a craniometer by the addition of metric scales. That proved to be the first step in the evolution of the craniostat into a radiographic cephalostat.

It did not take much longer for him to convert the direct-measuring instrument into a radiographic craniometer. X-raying skulls added to his appreciation of the importance of anatomical information in clinical orthodontics, and one-by-one the pieces were fitted together into a totally new research methodology.

The Bolton Contributions

Meanwhile, in the course of his orthodontic practice he corrected the malocclusion of Charles Bingham Bolton, son of Chester and Frances P. Bolton. That therapy dramatically changed the lives of all three.

His discussions of facial growth with Congresswoman Bolton kindled an interest that led to the addition of the Bolton Study of facial growth to the long list of Bolton philanthropies. As Charles grew to adulthood this study became a major personal as well as financial commitment.

Cephalometrics was not developed as a technique looking for an application. Nor was it developed as a diagnostic tool. Broadbent's single goal was the study of craniofacial growth, and he set out to design a research program with all of the tools necessary to accomplish that objective. The Broadbent technique for cephalometric radiography was one of the tools that he developed for the implementation of that study, which still continues today.[3]

Clinical Application

The research orientation, along with the finely machined and calibrated instrumentation, may have had an intimidating effect that contributed to the lag of almost two decades in direct clinical application. In retrospect, that was probably good.

By the time that the instrumentation had evolved to a form more suitable for the individual practitioner through the pioneering efforts of Margolis, Higley and even this Editor, the sound scientific base for such application was already in place. That scientific base was capped in 1948 by the pivotal publication of Downs' analysis.[4]

A Durable Technique

Nothing attests more to the thoroughness of Broadbent's approach to the design of the cephalometric method than the survival of the basic technique almost unchanged over the past fifty years. He did not present the profession with a premature infant in need of artificial life support and careful nurture. He gave us a gangling but vigorous adolescent ready to enter the work force.

Patient Orientation

The ears were established as the basis for orientation and fixation in the beam axis. Frankfort plane was adopted for horizontal orientation, with nasion for stabilization. Lateral and postero-anterior views perpendicular to each other in the horizontal plane were specified for three-dimensional analysis. All of those specifications for subject orientation remain as the central core of today's standards.

X-Ray Source Position

Target-to-subject distance is a critical dimension that involves a compromise of several factors. Broadbent's carefully considered selection of five feet (152.4 cm) still stands today. A change to 150 cm has been adopted by some as a conveniently round metric number, but the difference is negligible. For example, the line S-N is enlarged only about one tenth of a millimeter more by this change. Enlargement calculations and corrections are usually accomplished with a computer, and that technology can operate with either value with equal facility.

A major improvement in later cephalostats is the capability of taking lateral and P-A views with a single x-ray source instead of two.

Film Position and Enlargement

The other significant change from the original technique is adjustability of film position. The original cephalostat was based on the design of the anthropometric craniometer, and the finely calibrated millimeter scales were retained to record positions of earposts and nasion rest. Cassettes were attached to those mechanisms, so their positions could also be recorded with the same measurements.

The disadvantage of this very efficient mechanical design is that it makes cassette position and resultant enlargement dependent on head size. As the subject grows, left earpost and nasion rest move away from the x-ray source. When the cassette moves with them, enlargement is progressively increased at varying rates in both views.

This seriously hampers all serial evaluations.

Evaluation of serial changes by direct superimposition is a valuable clinical tool that is made so unreliable by variable enlargement that its use is virtually precluded.

Mandatory correction for enlargement in situations where it would otherwise be unnecessary may appear to be a mere annoyance, but it does add cost and one more source of error. This has had subtle but far-reaching effects on the evolution and application of methods for cephalometric evaluation. The cloud of doubt cast over linear measurements by variable enlargement remains to this day.

The relative immunity of angular measurements to enlargement distortion has combined with the difficulties of correction to lead many researchers to opt for angular over linear values wherever possible.

Newer instruments eliminate variable enlargement and its handicaps by providing independent adjustments for head-holding mechanisms and cassette. This enables standardization of cassette position and resultant enlargement at fixed values.

Unvarying enlargement makes direct comparison of serial films or tracings by superimposition a valid and accurate procedure. It also enables many other comparisons and evaluations without the need for enlargement corrections. Where enlargement corrections are still required, sources of error are reduced and the overall procedure simplified.

The Third Dimension

Clinical orthodontics has yet to fully utilize Broadbent's contribution. He gave us a three-dimensional analysis, but orthodontics has remained preoccupied with the lateral view. The patient is much more recognizable than in the frontal (P-A) view, especially with soft tissue enhancement. It is easy to work with. It is not enough.

We treat in three dimensions, and the width dimensions that are visualized on the frontal view are crucial in many cases. In these days of increasing awareness of the contributions of muscular and respiratory function, we can no more afford to continue to close our eyes to the information in the frontal view than we could afford to ignore the lateral view up to now. ***r c t***

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