Flotsam, Jetsam and Teeth

We do not know whether the first canoe builder ventured forth onto lake, stream or ocean for the maiden voyage, but let's assume for the moment that it was on a quiet little lake. Navigation under those conditions is rather straight-forward; one merely points the bow toward the intended landing site and maintains that orientation until arrival.

Crossing a stream becomes much more complicated. Pointing the bow directly across the stream will result in a landing some distance downstream, and keeping it pointed at the intended landing site on the opposite shore will lengthen the course and require some frantic paddling at the end. With a little experience and midcourse corrections, one soon learns to steer at an appropriate crab angle to maintain a direct course.

Valuable clues for navigating on moving water can be gained by watching the movements of floating debris (flotsam), but it is not as simple as merely setting a course with reference to the drifting debris. The whitewater canoeist reads every drifting bubble or other object that signals the direction of flow, but only as part of an integrated pattern that includes the direct and indirect images of rocks and shore as well as the moving water.

Flowing Bone

Facial growth and tooth movement involve similar patterns of flow as apposition and resorption move bony boundaries to cause a flow of living bone through the anatomic structures. The first insight into these processes came more than two hundred years ago, when Hunter fed madder intermittently to pigs and later studied the resulting pattern of red dye in their bones. The bone was colored red wherever growth was active at the time that the madder was in the blood stream, leaving a permanent record in a pattern somewhat resembling the growth rings of trees.

Studies since then, using progressively more sophisticated vital stains and other techniques, have developed a detailed picture of the complex patterns of apposition and resorption involved in growth. Marked bone is revealed as a bit of flotsam moving through what we might otherwise expect to be an immobile structure. The process is not unlike the progressive changes in the shoreline, reefs and bars of our figurative stream as bone literally flows through the facial structures.

Drifting Teeth

Teeth navigate within that flowing bone, maintaining their position within the structure through complex patterns of resorption and apposition. The orthodontist's challenge is to understand and guide their course, navigating like the canoeist by using all available clues to position, direction and velocity in relation to the flowing bone, the shore, and to the ultimate goal.

Classic cephalometric landmarks identify boundaries — shoreline markers that are as identifiable as lighthouses. This technique was developed long after

the internal bone changes were recognized, so even the earliest developers of cephalometrics were well aware that they were looking at changing margins of changing structures.

The first to toss discrete bits of jetsam into the bony waters was Humphrey, a hundred years after Hunter and still half a century before cephalometrics. He tied a wire loop into the ramus of a growing pig mandible and observed post-mortem its apparent anterior migration as the ramus grew. This demonstrated that the bone was growing posteriorly, with the previously-formed bone literally flowing forward through the structure of the ramus until it disappeared through anterior resorption. A segment of stream fed by a waterfall at one end and disappearing over a cliff downstream in another waterfall follows a similar pattern.

This histologic background was an integral part of the introduction of diagnostic cephalometrics into orthodontic teaching by Downs. It remained for Björk to further expand our understanding of the human face with his landmark implant studies. He tossed little tantalum implants into the bony stream in the symphysis region, where they decisively verified what earlier animal studies could only suggest; that the symphysis behaves much like the ramus, building up posteriorly (lingually) and resorbing anteriorly, spilling out an implant as surely as a drifting vessel is plunged over a waterfall.

The loosely-joined raft that we call the dentition must actually paddle upstream through this anterior flow of bone just to maintain a stable relationship with the surrounding structures.

Since those first symphysis studies, implants have been used by Björk and others to study the flow of bone through various structures of the face as apposition and resorption reshape these complex structures. This translocation of bone through the structures of the face has caught the imagination of many, sometimes to a point where the total picture is forgotten and the flowing stream is viewed as an ultimate "stable" reference.

What is Reality?

This rebirth of interest in underlying growth processes has both clarified and confused the understanding of facial growth and development, particularly as it relates to the superimposition of serial cephalometric radiographs. Is a stream defined by its banks or by the water that they hold? Is the progress of a canoe defined in relation to the water or to the rocks and banks? Is the same water or bone really still the "same" as it moves into new locations and assumes different functions?

There are no right or wrong answers to those questions. All stability in the face is relative. VALIDITY is not an appropriate term in this context, because any superimposition on identifiable structures is valid; however, interpretations based on superimposition must be made with full awareness that the picture is incomplete without consideration of both the stream and its banks.

Some say that the mandibular border is not a valid reference because it is continually remodeling during growth, but that very remodeling gives it a stability of its own in relation to the overall face and the mechanical support functions, while "stable" internal structures are translocated into different functional milieux. The importance of the mandibular border in defining facial form and function is not diminished by the mechanisms of its formation.

Checking relationships to the tantalum jetsam or surrogate anatomic structures helps us to evaluate changes and follow the course of a particular segment of bone as it is translocated vertically through the palate or horizontally through the symphysis. This added insight can greatly enhance our treatment as we try to move teeth and bone to best serve the patient's needs, but it is not an adequate guide by itself. Casting a lightship adrift in the gulfstream does not affect the validity of sightings based on it, but they can be virtually useless without collateral information on the lightship's changing location in relation to the shore.

WE MUST NOT CONFUSE PROCESS WITH PRODUCT. Our goals and our success or failure are still based on the ultimate shape of the patient as defined by the bones, soft tissues, and dentition. Internal changes in the component structures are essential parts of the process as the total structure and environment interact to create the ultimate facial form and function, but preoccupation with the drifting tantalum jetsam or surrogate anatomic structures without also keeping an eye on the shore can be an invitation to disaster.

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