Technical Note: Simplified Alignment of Articulations to Positive Models

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Introduction

The importance of precisely aligning mechanical articulations with one another to reduce friction and joint wear is well known (1). Many external alignment fixtures have been developed to facilitate this process (see Figure 1).

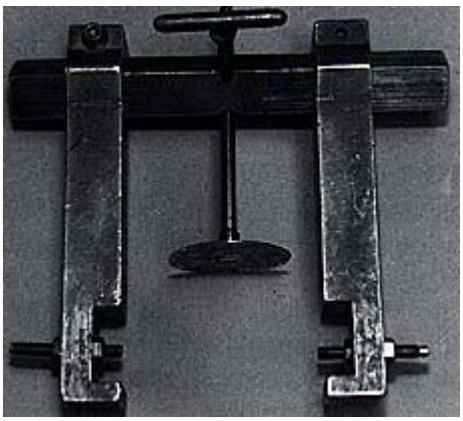

Figure 1. External alignment fixtures, such as the one pictured here, maintain alignment of articulations with one another but are often difficult to stabilize in precise anatomic locations on the positive model.

Recent literature shows an increasing interest in placing the external ankle joint in greater congruence with the anatomic axis (2). But, particularly for pediatric clients whose ankle mortises are anomalous secondary to neuromuscular deficits, it can be difficult to maintain both triplanar anatomic congruency and articulation alignment simultaneously using existing external fixtures.

Although the technique of placing an internal fixture within the negative impression before filling it with plaster is well established, no pediatric sizes are available (see Figure 2) (3,4). It is sometimes difficult to determine precisely the proper anatomic location deep within small pediatric impressions, and the extra time necessary to place and later clean internal fixtures adds cost to the procedure.

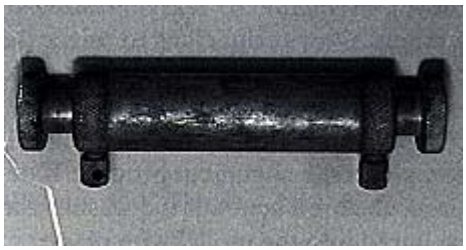

Figure 2. Internal alignment fixtures are not available in pediatric sizes and are difficult to place precisely-particularly deep within pediatric negative impressions.

A simplified alignment procedure that avoids these problems has been developed and was received enthusiastically during a workshop for practitioners from Central and South America (5). Since the necessary fixtures can be fabricated easily and only a drill press is required for implementation, this technique has proven to be practical and inexpensive in a variety of practice settings.

Technique

Placing a threaded rod in the negative impression, which enters and exits at precisely determined anatomic locations, can readily establish both anatomic congruency and articulation alignment in all planes (see Figure 3). However, this approach is often impractical since the protruding rod interferes with placing the reinforcement mandrel within the cast, particularly pediatric cases.

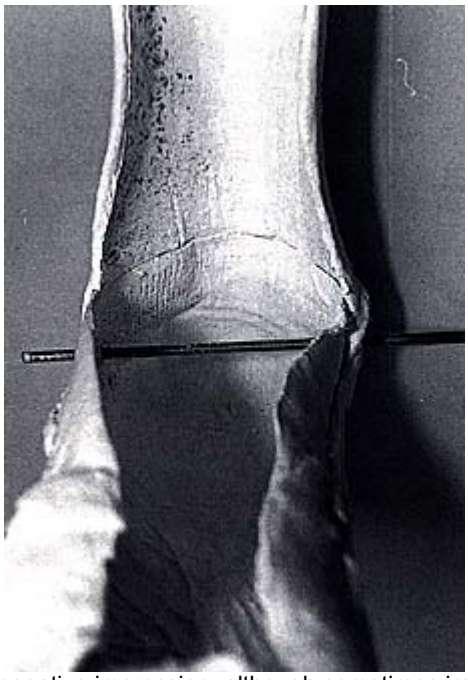

Figure 3. Placing a threaded rod through the negative impression, although sometimes impractical, would establish both anatomic congruency and articulation alignment in all planes.

It is easier to simulate the threaded rod by boring two perfectly aligned holes from opposite sides of the finished positive model, using a modified drill press. The drill fixture consists of five-inch square of 3/4-inch plywood (13x13x2 cm) with a protruding steel pin perpendicular to its surface. A broken drill bit, pressed into a slightly undersized hole, makes a durable alignment pin. This assembly is clamped to the drill press so the tip of the drill bit and the steel pin align precisely (see Figure 4). The practitioner marks the desired anatomic joint centers with an "X" or both sides of the positive model. The technician then drills a shallow two mm (1/8-inch) hole to identify the medial joint location. The model is rotated so the two-mm hole keys onto the steel pin and the center of the lateral articulation is directly under the drill bit (see Figure 5). The technician then bores into the model to create the lateral alignment channel, stopping just short of the reinforcement mandrel. The model is then rotated and placed with the steel pin inside the lateral alignment hole. The medial side is drilled similarly.

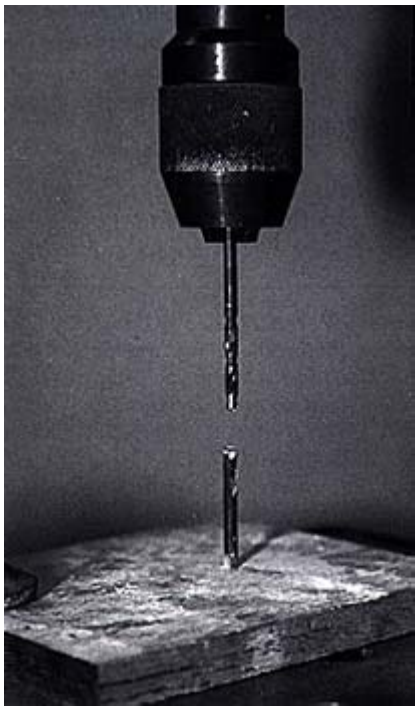

Figure 4. This simple fixture consists of a perpendicular steel pin clamped to the drill press in alignment with the drill bit.

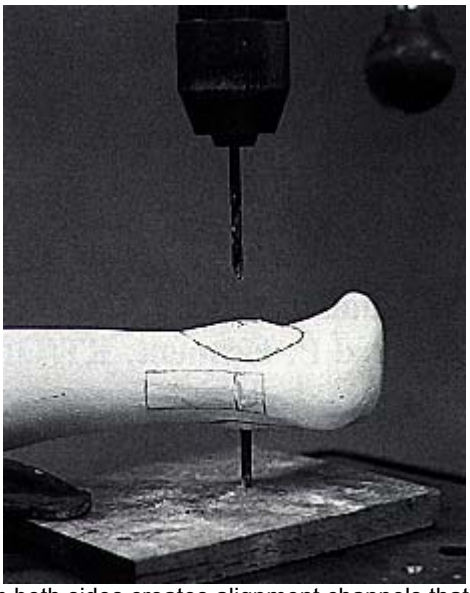

Figure 5. Boring into the plaster model from both sides creates alignment channels that would intersect if not for the pipe mandrel.

Fixtures to form a flat articular surface are created by brazing steel washers onto number 26 copper rivets as shown in Figure 6 . Varying sizes of washers allow technicians to select the optimal configuration for pediatric and adult orthoses. Pushing the rivet post snugly into the alignment channels completes the alignment process. If desired, the area beneath the washer can be faired into the model with plaster of Paris or polyethylene foam pads (see Figure 7).

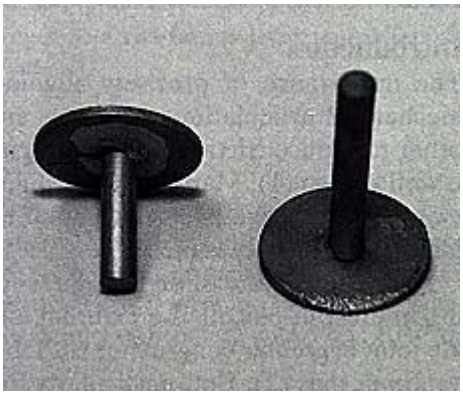

Figure 6. Steel washers brazed onto rivets create a flat surface perpendicular to the alignment channels.

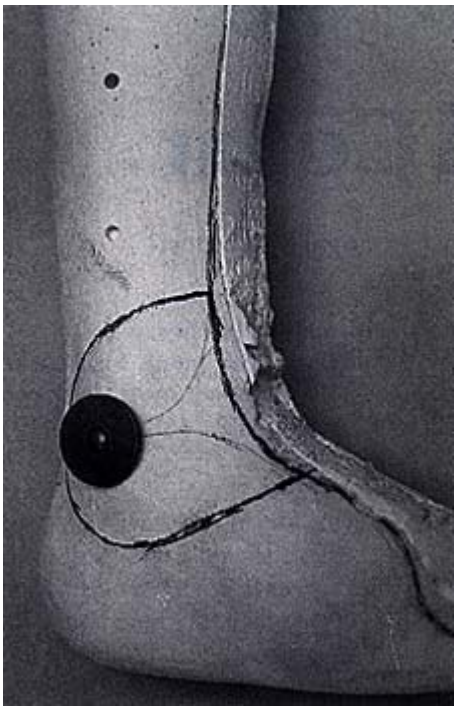

Figure 7. The area beneath the washers can be faired into the model with skived polyethylene foam discs or plaster of Paris

Conventional vacuum-assisted thernoplastic molding over the model and fixtures creates a plastic orthosis with perfectly congruent and aligned circular areas ready for joint placement or a second pull of plastic to form an overlap joint (see Figure 8).

Figure 8. Vacuum-assisted thermoplastic molding creates a flat surface for joint placement or to form the articulation following a second pull of plastic.

It is also possible to modify any of the commercially available articulations to permit alignment with this technique by replacing the articulation axis with a longer machine screw. Pushing the protruding machine screw snugly into an appropriately sized alignment channel maintains congruency so the thermoplastic can be molded directly over the commercial joints (see Figure 9).

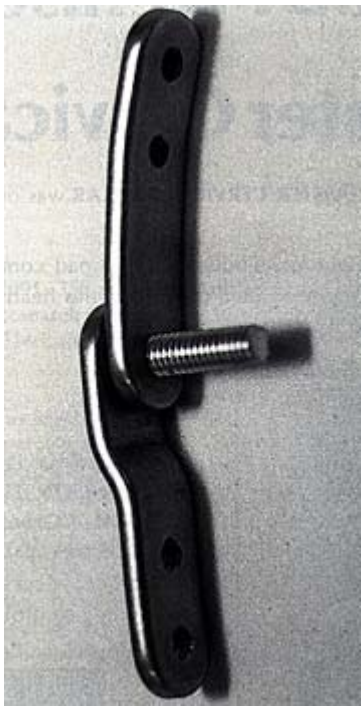

Figure 9. Replacing the manufacturer's axis with a longer machine screw will adapt a variety of commercial joints for alignment with this technique.

Conclusion

This technique has been used for the past six years on hundreds of articulated designs and proven to be simple, reliable and replicable. It can be applied to any articulation, including finger, wrist, elbow, hip, knee and ankle joints. Although more commonly used for orthotic design, the same technique can be used to align lower-limb and upper-limb prosthetic joints as well.

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