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Aiming Accuracy and Reliable Opposite Site Cortical Sparing Wedge Osteotomy Technique – A Surgical Trick

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1. Introduction

Osteotomy is one of the most ancient orthopaedic procedures still used today (Macewen, 1880). Osteotomy means the severance of a bony structure. It can be made for different purposes, such as ablation of an unneeded or disturbing bony prominence, elimination of an unhealthy bone segment or modification of the axis of a bone among others. When performing an axial correction on a bone, most frequently we make a wedge osteotomy, which is a common procedure in orthopaedics. To perform this we have two options. The first option is to cut across the whole bone with the elimination or addition of a triangular or trapezoidal piece of bone, or the cut section is incomplete, that is the opposite cortex is spared (Toksvig-Larsen 1992).

2. Background and surgical technique

Axial correction is carried out most often on long bones. Human long bones are tubular. Stress analysts distinguish two types of tubes, the thin and the large walled ones because of their different mechanical behaviour. A tube reacts to the bending force depending on its wall thickness. Due to genetical determination and the fact that the long bone is a living structure frequently receiving bending stress, its tubular form is consequently differing from a regular tube. This way the long bones are similar to irregularly shaped thick walled tubes.

However when we are correcting the axis of a long bone by means of preliminary incomplete cut, shear forces rise in the remaining part of the tube wall, which has a short section curved area. Incomplete section means that the bone is only partially cut, this way sparing the cortical on the opposite site. Also there is a difference if the cut end is just next to the inner cortical wall or if it is also biting it a bit (Fig. 1.).

This remaining integral cortical will serve as a hinge when correcting the angle (Fig. 2.). Depending on if we are carrying out an opening or a closing wedge osteotomy the stress rising on this cortical will be inverse. During opening wedge osteotomy in the external half of the cortical a compression stress, while in its internal part a tension stress occurs (Fig. 3.). In case of a closing wedge osteotomy the stress distribution appears inversely.

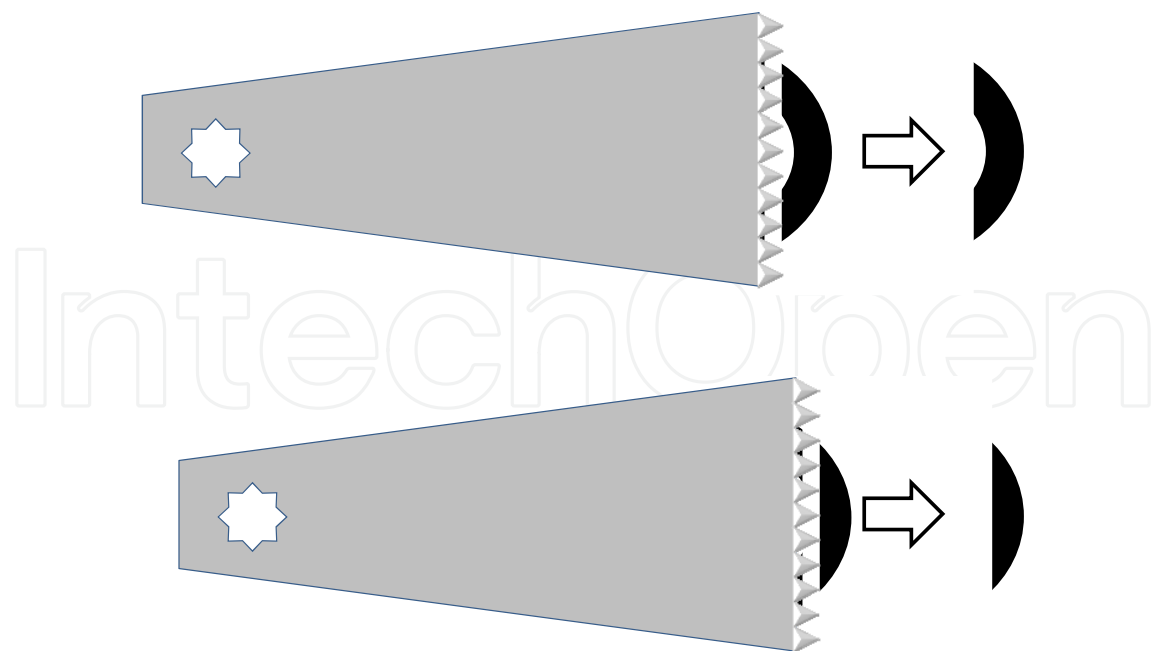


Fig. 1. Schematic drawing of the two types of incomplete cuts. The top figure shows the cut when the inner cortical wall is not reached, and the bottom figure shows the cut where the cut extends to the inner cortical.



Fig. 2. Schematic drawing demonstrating opening and closing wedge osteotomy on long bones.

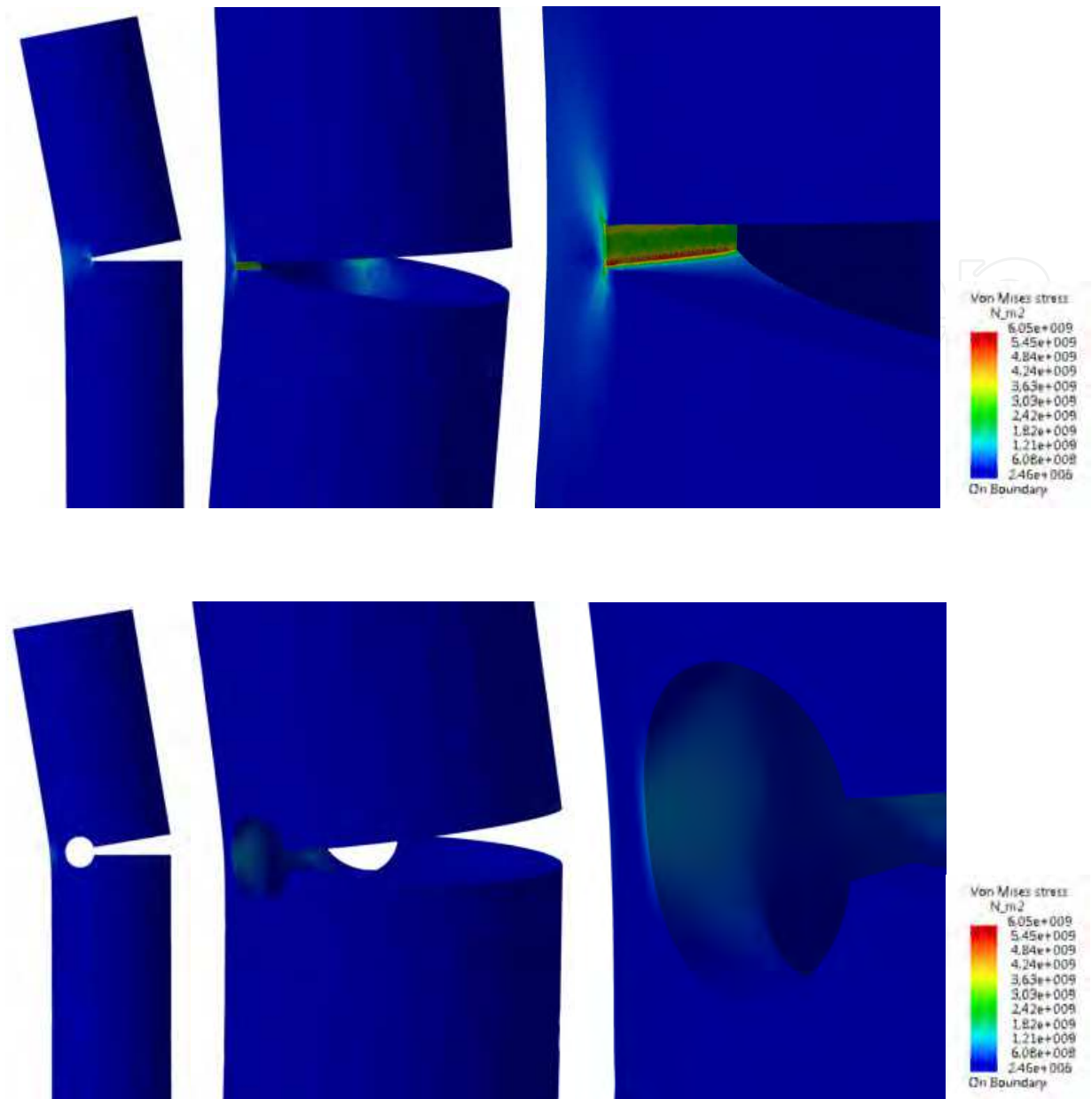


Fig. 3. Finite element model of the stress rise in case of opening wedge osteotomy in case of traditional cut (top) and after a perpendicular drill hole (bottom).

Irrespectively if we are opening or closing, the rising stress risks to surpass the resistance of the remaining cortical bone resulting in its break through, this means the loss of the hinge (Miller et al., 2009). If there is no hinge, the task of osteosynthesis is burdensome. In this case since the nature of the operation changed, the required osteosynthesis hardware and technique is completely different (Fillinger, 2001).

Up to this point we considered bone as a homogeneous material. However we have to keep in mind the importance of the bone’s microstructure hierarchy on its mechanical properties. Crack initiation, propagation and finally completion is somehow resisted by the longitudinally oriented osteonal architecture. This way stress concentration itself does not determine the occurrence of material failure.

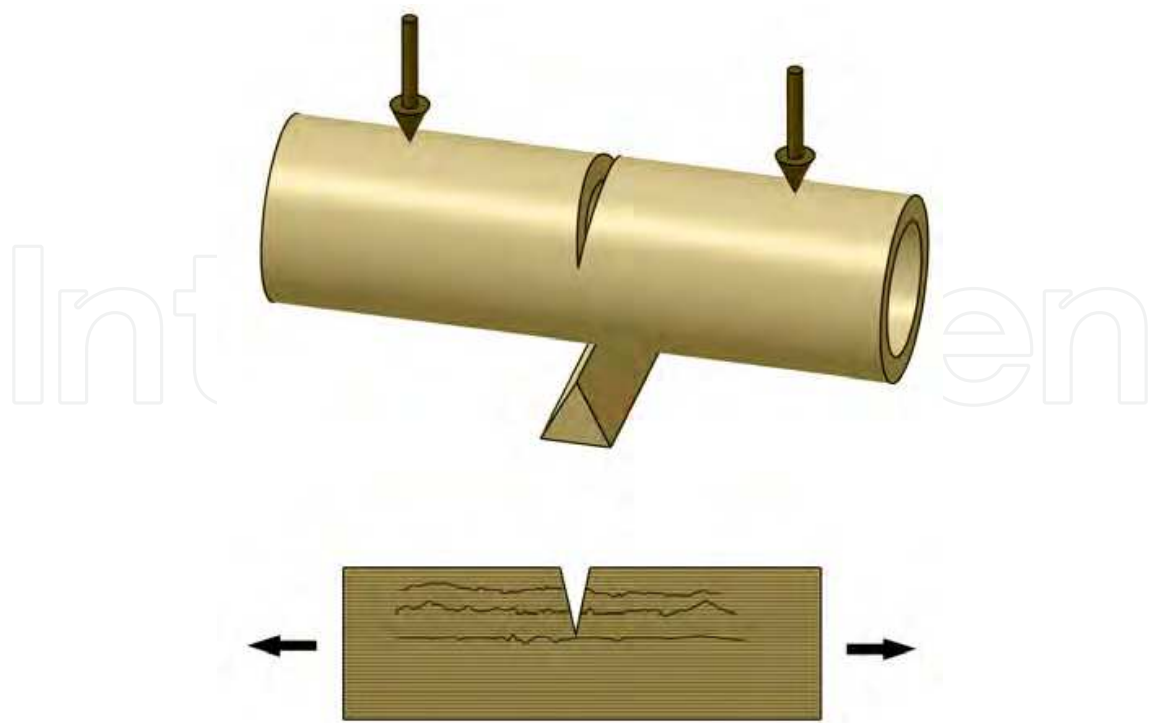


Fig. 4. Crack propagation following incomplete sharply ending cut.

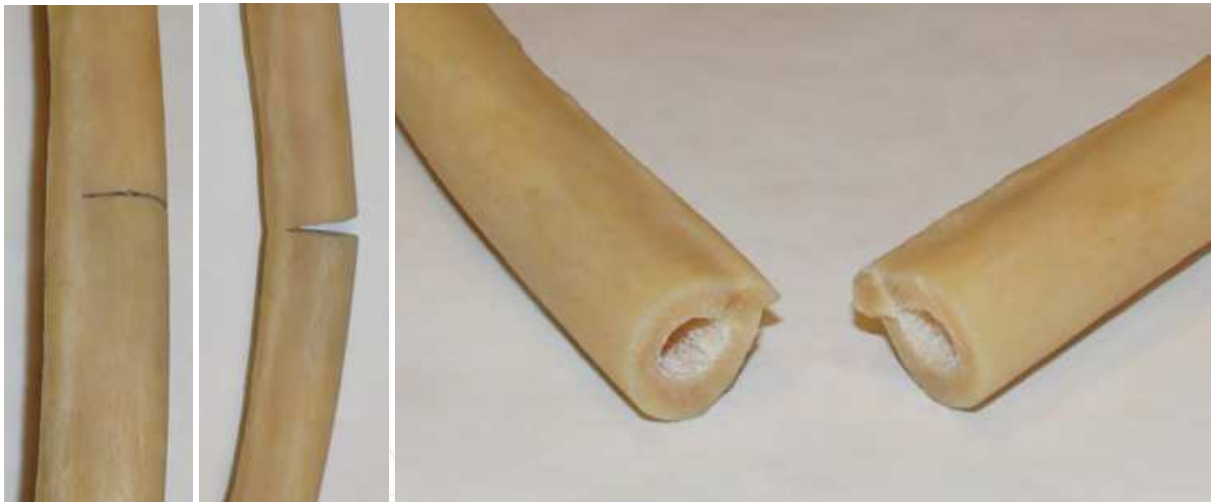


Fig. 5. Incomplete cut on a femoral diaphysis broken through during an opening wedge osteotomy.

If the vitality of the bone is not compromised by excessive devitalisation during the operation and the correcting manoeuvres don't cause immediate failure, the viable bone responds by an expedient remodelling process according to Wolff's law.

We felt that there is a lack of a technique which secures reliable control of sparing opposite site cortical (Fig. 5.), that is why we had recourse to a wide spread craftsman's method. All carpenters and locksmiths know that when performing a partial kerf cut before bending a piece of wood or metal the best way to make it safe, preventing breakage, is to drill a hole receiving the cut slot (Fig. 6.).



Fig. 6. A safe way to realize a serial incomplete wood cut for bending.

We adapted this technique during opening and closing wedge osteotomies in our clinical practice since 2006 (Csernátóny et al., 2008). The method consists of drilling a juxtacortical hole positioned at the desired ending of the osteotomy cut. The diameter of the drill bit depends on the diameter of the bone cut. For instance in case of a proximal tibia osteotomy a 6 to 8 mm diameter is suitable, while in case of the first metatarsal bone a 4.5 mm diameter is sufficient (Fig. 7.). Here too it has an importance if the drilled hole is just against the inner cortical wall, or entering it, or is somehow away from it (Fig. 8.).

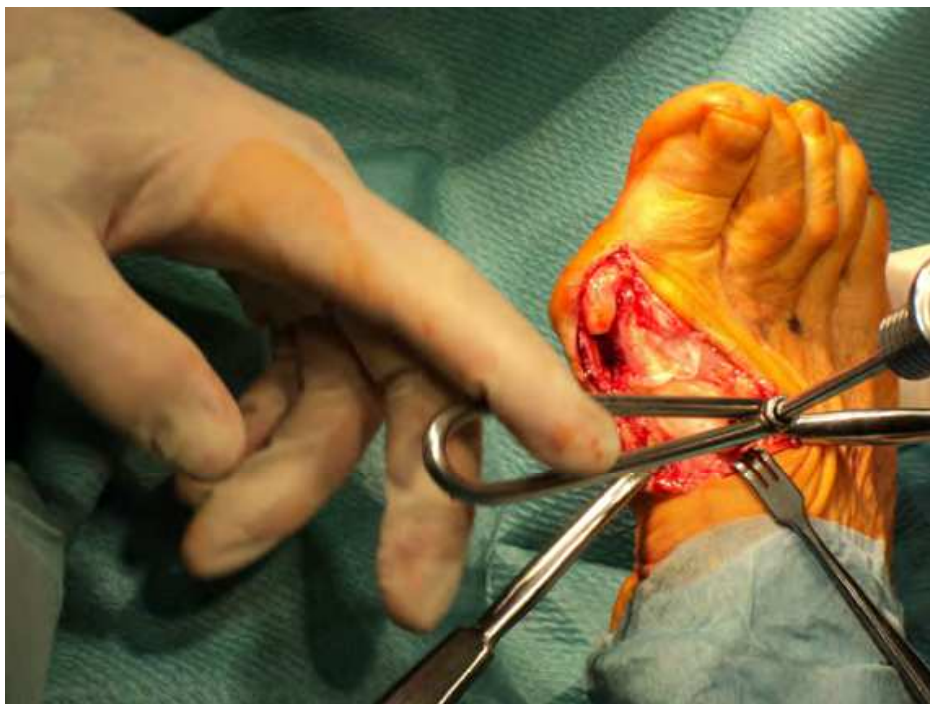


Fig. 7. A 4.5 mm drill hole is made on the opposite cortex in case a proximal osteotomy for metatarsus primus varus.

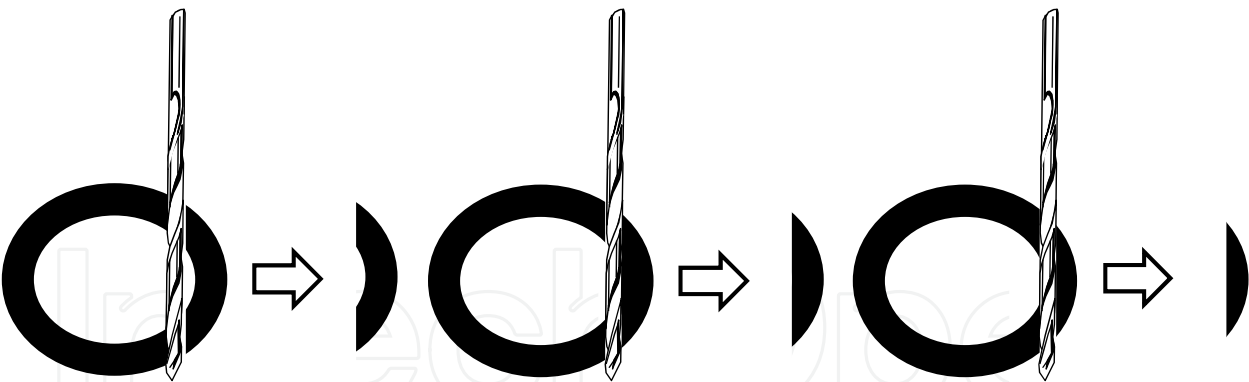


Fig. 8. Schematic drawing showing the three possible drill holes next to the opposite cortex.

Another practical difficulty in case of freehand bone cutting is the accuracy of cut. Preciseness might be easily disturbed by the fact, that only a small part of the leg is exposed during surgery and all remaining part of the body is covered with isolating sheets. One of the often used techniques is direct pencil marking on the bone. However many circumstances may divert during an operation the surgeon’s attention, so reliable guide for precise execution is necessary.

Our way of execution adds a solution to the aiming of the osteotomy orientation. If the drill bit is left in place after removing it from the chuck, the drill bit can serve as a tracer guide when performing the osteotomy of the bone (Fig. 9.). Preciseness requires only directing the saw blade onto the midline of the drill-bit. After the osteotomy is performed the drill-bit is removed and the opening or closing wedge osteotomy is performed as usual (Fig. 10.). The drill hole on the opposite cortex decreases the amount of stress on the cortex and this way the chance of fracture is also decreased.



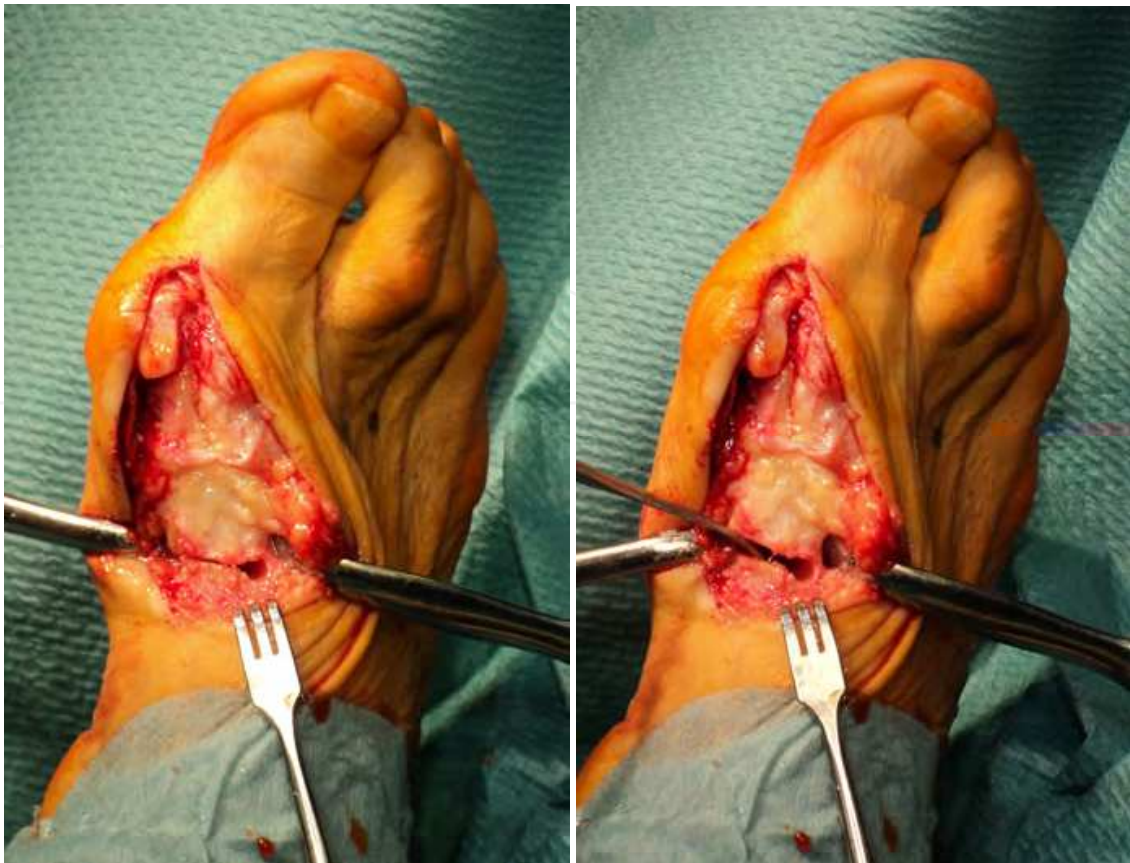


Fig. 9. Performing the osteotomy while using the drill-bit at the opposite cortex as a guide



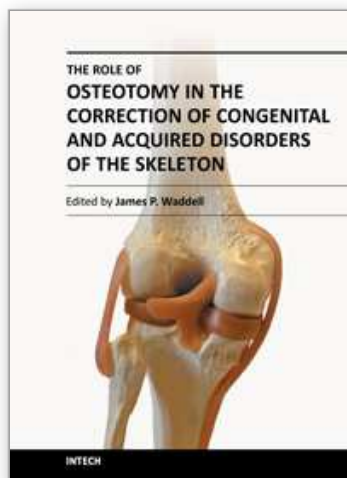
Fig. 10. In this opening wedge osteotomy the bone removed from the bunion is impacted into the osteotomy site.

3. Conclusion

We think that on the one hand nowadays in some fields of surgery we are over assisted by highly sophisticated instruments and navigation systems, however on the other hand there are still frequently used techniques relying simply on good manual skill. Our technique adds to the surgical precision without the invocation of a new dear instrumentation.

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This book demonstrates specific osteotomy techniques from the skull to the hallux. The role of osteotomy in the correction of deformity is under appreciated in part because of the ubiquitous nature of joint replacement surgery. It should be remembered, however, that osteotomy has a role to play in the correction of deformity in the growing child, the active young adult, and patients of any age with post-traumatic deformity limiting function and enjoyment of life. In this text we bring you a number of papers defining specific problems for which osteotomy is found to be an effective and lasting solution. I hope you find it useful.

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