CASE REPORT – CRANIAL VAULT REMODELING

Introduction
Craniosynostosis is a congenital disorder that occurs when the sutures between the bones of a child’s skull prematurely fuse leading to the development of an abnormal head shape and occasionally increased intracranial pressure. The disorder is relatively common and affects approximately 1 in every 2500 live births and can contribute to calvarial deformity, increased intracranial pressure and neurodevelopmental impairment. Several surgical procedures have been developed to correct deformities associated with craniosynostosis. Regardless of the surgical technique used, cranial vault remodeling still requires a significant degree of subjective assessment by the surgeon, both pre-operatively and intra-operatively, to determine how to remodel the calvarium to best restore normal head shape.

Computer-assisted procedures are gaining more credibility in the field of head and neck surgery. Combined with three-dimensional (3D) data, these methods have been used previously for other complex reconstructive procedures such as cranioplasty and craniofacial reconstruction. Applications range from surgical planning, computer-aided design (CAD), computer-aided manufacturing (CAM) of implants to creation of surgical guides for bone resection or bone reconstruction, to assist in craniosynostosis surgery.

Case Presentation
A boy presented with abnormal head shape was diagnosed with metopic synostosis (trigonocephaly) (Figure 1). After virtual surgical planning (VSP), he underwent cranial vault remodeling (CVR) at 10 months of age.

To achieve optimal shape, the supraorbital bandeau and frontal bones were segmented into pieces. Plating was done on the outside, using resorbable screws and plates.

Treatment
The planning allows the surgeon to produce marking guides that are used by the surgeon to mark the desired areas on the skull to be cut. This transfers the virtual surgical planning into theatre.
Figure 2 shows the VSP performed according to the surgeon’s indications. The planned cuts are then translated into marking guides, which are used intra-operatively by the surgeon to mark the areas that need to be cut (Figure 3).

The pre- and post-operative images showing the correction of the trigonocephaly are contained in the figure below.
Discussion
The goal of CVR is to correct the cranial shape as much towards the normal as possible, for the individual patient. The application of VSP and guide assisted CVR is a natural evolution in surgery for craniosynostosis. The technique allows reproducible objective results that improve outcomes regardless of the expertise of the surgeon.

The advantages offered by VSP must be balanced against the necessity for radiation exposure in infants during acquisition of the CT scan and cost of the technology. Ultimately, VSP does not obviate the need for good technical expertise but instead compliments it and may be most useful for complex multi-sutural craniosynostosis where freehand osteotomy and shaping of the calvarium may result in less predictable results.

An additional benefit of pre-operative modelling is that it allows a more thorough understanding of the disease pathology and surgical process for the parents of affected patients through providing a more visual comprehension of what is being undertaken. Patients and families have a significantly better understanding of the operation due to pre-operative counselling before undergoing surgery and post-operative rehabilitation. This results in better alignment of hopes and expectations between families and surgeons. The increased front-end pre-operative workload leads to increased efficiency in the operating room and may eventually lead to decreased operative times due to elimination of any guesswork intra-operatively.

Conclusion
The use of 3D virtual surgery pre-operatively and marking guides allows for a precise surgical reconstruction with restoration of normal calvarial morphology. In addition, patients and family will have a significantly better understanding of the problem and the challenges of reconstruction. This results in better alignment of hopes and expectations between the families and surgeons.