Short communication

Augmented reality guided condylectomy

Thijs Bussink, Thomas Maal, Jene Meulstee, Tong Xi

Abstract

An accurate transfer of a 3D virtual planned proportional condylectomy to the patient is challenging due to the limited surgical access. A new clinical workflow that uses augmented reality to assist a condylectomy is presented step-by-step. This AR-based approach has the potential to be implemented in the clinical setting routinely.

Keywords: 3D planning; Augmented reality; Condylectomy; Guided surgery; High condylectomy; Hololens

Introduction

Proportional condylectomy is increasingly being used as an initial treatment in unilateral condylar hyperplasia. The key in proportional condylectomy is able to place the osteotomy plane at the desired location to reduce the vertical ramal asymmetry. Clinically, it remains challenging to transfer a virtually planned condylectomy plane to the patient during surgery. The limited surgical access, the axial location of the condylar head, and the seating of condyle in the fossa often restricts a complete overview of the condylar head and hampers the use of surgical guides. The implementation of augmented reality (AR) can aid surgical interventions by presenting images of 3D virtual surgical planning on the operation field. We present a novel AR-guided workflow for condylectomy.

Material and methods

A 38-year-old female presented at our department with a progressive chin point deviation to the right based on unilateral condylar hyperplasia. A proportional condylectomy of the left condyle was proposed.

Surgery was performed under general anaesthesia with nasotracheal intubation. The left condyle was approached through a post-tragal incision with a limited superior preauricular extension. After gaining access to the condylar head, the surgeon identified the plane of condylectomy visually. Three marking points were placed on the lateral condylar surface with a round bur.

By wearing Microsoft Hololens2 (Microsoft), the position of three markings was checked using the following steps:

1. A sterile quick response (QR) marker was attached to the lower dentition to allow tracking of the mandibular position through Hololens2.
2. A stainless-steel pointer, equipped with a second QR marker, was used to check the location of the planned osteotomy line (Fig. 1).
An Unity-based inhouse-developed Hololens application, enabled the surgeon to visualise the planned position of the osteotomy line and the three markings. The Hololens displayed a virtual arrow at the location of the pointer to direct the surgeon to move the pointer to the planned position (Fig. 2).

Next, the actual condylectomy was performed with a round bur based on the markings. The cranial part of the condylar head was removed.

Five days following surgery, a postoperative check-up CBCT was acquired. The planned and actual location of the condylectomy planes were compared.

Results and discussion

The 3D registration of planned and postoperative mandibular models (Fig. 3) showed that on the lateral, anterior and medial side of the condyle, the condylectomy was performed almost exactly as was planned (error ≤ 1 mm). However, the postoperative posterior border of the left condyle was located more caudally compared to the planning. This discrepancy could be a result of the fact that only the lateral position of the osteotomy was verified by Hololens2.

The accuracy of the presented method should be further investigated in future research. Besides, the software can be improved to make the AR application more intuitive. To eliminate the use of the pointer, the surgical handpiece (and thus the bur) can be equipped with a QR-code so that the position of the bur can be tracked and corrected throughout surgery. The magnitude of the registration error, perception error and surgical error in AR-guided surgery should be investigated thoroughly.

Although conventional surgical navigation systems can be used to guide the user during surgery, the combination of the Hololens with sterilisable QR markers is an easy and low-cost alternative. This AR solution allows the user to stay focused on the surgical field while attaining feedback from the planning. The surgeon is not forced to switch his/her view to an external monitor as in conventional navigation.

We believe that AR guidance is an adequate method to transfer a virtual planning for various CMF procedures. Especially during proportional condylectomy, where surgical guides are impractical, AR guidance is an effective method to assist the surgeon.
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Conflict of interest

No.

Ethics statement

Ethics approval was obtained from the institutional ethics review board (#2019-5986). The ethics committee has passed a positive judgment on the study. Radboud University Nijmegen Medical Centre confirm the study doesn’t fall within the remit of the Medical Research Involving Human Subjects Act (WMO). Patients permission obtained.

Sources of support

None.

References