



Three-dimensional printed thumb retractor: a low-cost and effective instrumentation for hand surgery

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Hand trauma, including thumb lacerations, forms an increasingly significant part of the acute trauma burden in most plastic surgery centres with more than 59,000 injuries in the United Kingdom in the year 2014–2015 and will often require exploration of injuries and repair of any damaged structures [1]. Junior plastic surgery trainees will frequently have to perform these types of cases independently early on in their training, and sometimes without an assistant. Volar lacerations to the thumb are difficult to access, especially without an assistant to optimise positioning. There is, however, no ideal position, and to our knowledge, there is no existing retractor to hold the thumb whilst the exploration is undertaken.

Whilst current instrumentation does not include a good solution for thumb stabilisation, 3D printing technologies allow for rapid prototyping of customised and novel solutions for surgical instrumentation. It has previously been demonstrated that a 3D printed hand retractor provides a novel alternative to the traditional lead hand [2, 3] and here we describe the development of a modular component which allows for positioning of the thumb to allow for access to the volar aspect without the need for an assistant ([Supplementary video](#)).

The hand retractor and additional components were designed and produced as previously described [2, 4]. The printing time for the two thumb components shown in Fig. 1 was 40 min and for all components, the total time was 310 min. The 3D printed retractor and thumb components were autoclaved at 121 °C under 15 psi of steam pressure for 30 min before each use, and the sterilisation process utilised biological indicators (BIs) to confirm sterility of the instruments post-process. The total material costs of the retractor

and the two thumb elements based on weight of material used (100 g) were estimated to be 4.7 GBP. Approval for clinical use of the customised 3D printed devices was subjected to a rigorous approval process as class I devices as per the UK government Medicines and Healthcare Products Regulatory Agency guidelines (Low-risk, Non-invasive, Non-implantable).

We have applied the thumb retractor on a patient that required exploration on the volar aspect of their thumb (Fig. 1). The thumb element is secured in the pre-existing channels of the hand retractor and allows for the thumb to be positioned in the z-axis for optimum access to the surgical site and is available in different sizes to accommodate the majority of patients (Fig. 1A,B). The vascular loop can be loosened or tightened and allows for stabilisation of the thumb in a semi-flexed position for flexor tendon or digital artery repair if the ends cannot be approximated without tension (Fig. 1A). We have found that the thumb can be reliably positioned without requiring frequent re-adjustment. The retractor is also radiolucent to allow for use of the C-arm without needing to reposition the retractor. Both the base and the additional thumb retractor element have anchoring points which can be used to position stay sutures for soft tissue retraction (Fig. 1C). Particularly during the peak of the COVID-19 pandemic, this has allowed for improved surgeon autonomy at a time when many operative lists were being run by a single surgeon without an assistant.

Overall, 3D printing technologies allow for innovative solutions to be produced quickly in response to a clinical need and can be refined in-house to provide for customised results. The ability to rapidly prototype and trial innovative solutions to commonly encountered surgical problems may help to bridge the gap between big industry and surgeons who come across issues in their practice that may not have attracted the funding needed to resolve them. This customised retractor is an example of the possibilities arising from 3D printing that can be applied to the surgical instrumentation field and can be put into production on a local scale in

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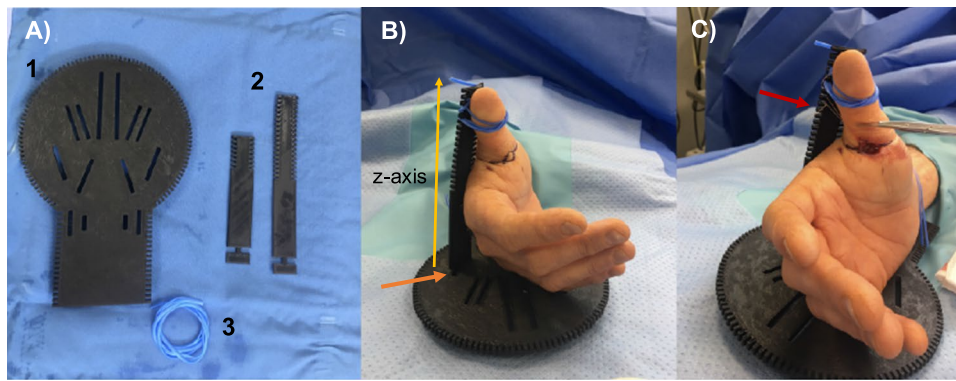


Fig. 1 **A** The 3D printed hand retractor (1) with two additional thumb elements of different size (2) and vascular loops (3). **B** Stabilisation of the thumb on the z-axis using the additional component (orange arrow demonstrates the connection between the thumb element and

order to tackle issues that are often faced in the operating theatre.

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Declarations

Ethics approval This case report was conducted complying with the ethics requirements of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. No ethical approval was required for this case report.

Informed consent Informed consent was obtained from the participant included in the study.

Patient consent Patient signed informed consent regarding sharing his data and photographs.

the main retractor) **C** Stay stitch can be then secured on the anchoring points of the thumb component to allow for soft tissue retraction (demonstrated with the red arrow)

Conflict of interest Dr Papavasiliou is a co-founder of Stelth, a company that specialises in 3D printing. Drs. Crooks and Uppal declare no conflict of interest.

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