Review of: "Additive Manufacturing of a Miniature Functional Trocar for Eye Surgery"

Andrew Baxter Reid[1]

1 University of Strathclyde

Potential competing interests: The author(s) declared that no potential competing interests exist.

This work offers design workarounds to circumvent the print limitations of a closed or automated SLA 3D printer, applied to the case study of a trocar. For my limited medical understanding this is a hollow microchannel and a non-return leaved valve. The application is interesting, and the workarounds the authors have used are creative - particularly the formation of the leaves of the non-return value in the open position and then post curing in closed position. The limitations encountered could be more deftly avoided by using a more appropriate system and resin for the task, which the authors counter by pointing out that such closed systems are designed to be operated by medical professionals rather than CAD / CAM professionals and therefore would be expected to continue to be the norm. Of course it is possible to design a closed system geared to the production of micro-cavities - if there is a demand for it.

One particular oversight in the text is the choice of resins, which the authors claim make little difference to the printability of the original design. Unfortunately they have chosen a very limited selection of FormLabs' own resins, which all have similarly low critical doses (the minimum energy required to bring the material to gelation) and low UV attenuation as they are designed to print rapidly. I would recommend Noreiga et al. (https://doi.org/10.1038/s41467-021-25788-w) or Gong et al. (DOI: 10.1039/C5RA23855B) to demonstrate the difference a properly tuned feedstock resin may make.

The issue with greater layer spacing resulting in channel walls which were too fragile raised some questions - it's not clear whether this is due to some dimensional inaccuracy or lack of cross-linking density. Possibly as the original design has walls of only 50um there would be limited structural integrity from the material in any print parameter case - I note the final helical design has a wall thickness of approx. 400 um due to the need for more internal space to accommodate the overprinting. This appeared to make the design unsuitable for the intended application, and rather rendered this part of the workout moot.

I think the most interesting part of this paper, from my more mechanical perspective, is the idea of printing deformed parts and reorienting them during the post cure phase. I would very much like to see what the limitations of that approach might be in terms of resin compliance and the residual stresses in the completed build.