Personalised Drug Delivery and Testing by 3D Printing

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Background

Inter-individual variations pose a major challenge in clinical practices. Furthermore, limitations of mass-produced medicine meant that it is difficult to use current dosage form for personalised medicine. In addition, clinical trials often do not include special populations such as geriatrics or paediatrics.

Therefore, there is a need for personalised drug delivery and testing to enable an individualised therapy

Method

Computer Aided Design of Personalised Dosage Form or Testing Device → 3D Printing Using Appropriate Biocompatible Material → Physical Characterisation (Dimensions; Mechanical Strength etc) → *Functional Characterisation (Safety & Efficacy)*

Customisable , Zero-order Tablet for Epilepsy

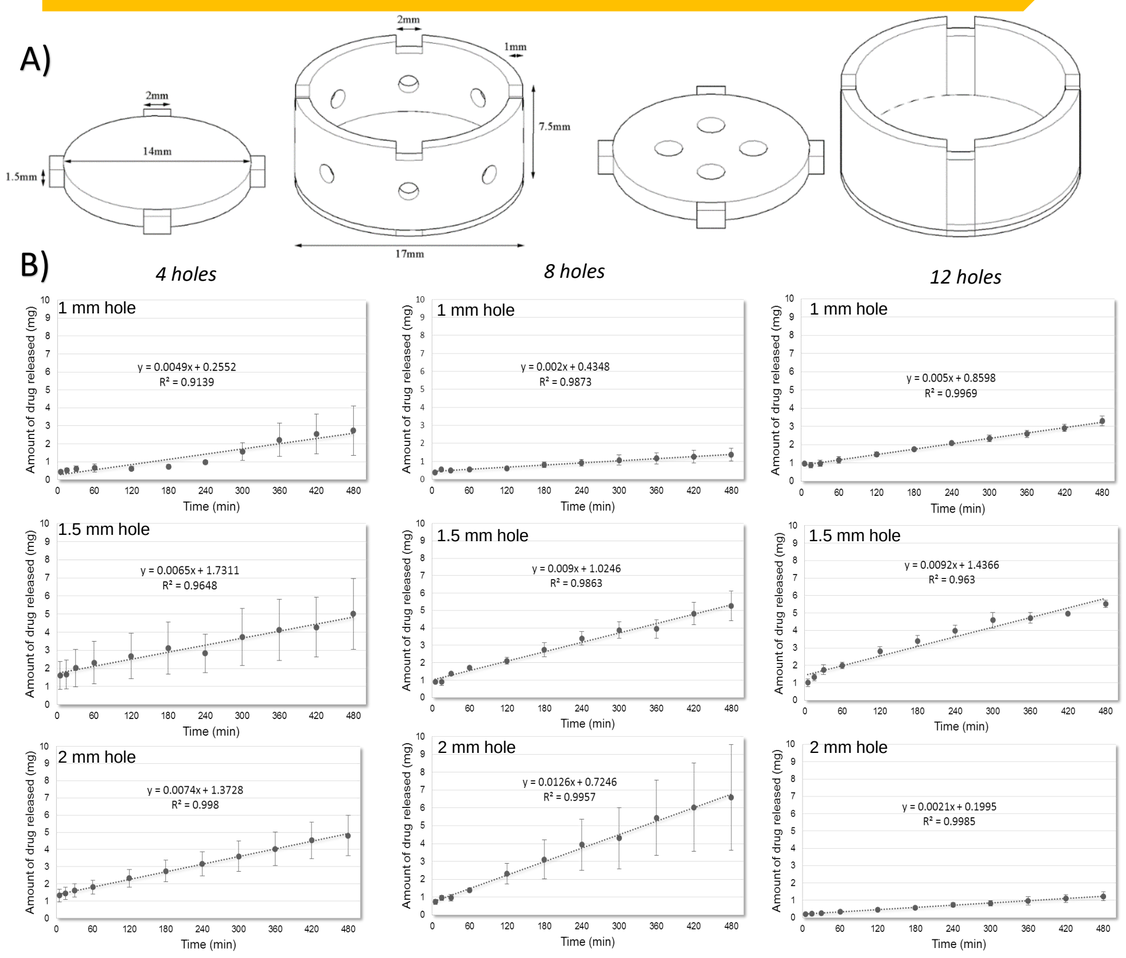


Figure 1: Summary of the development of zero-order drug release kinetics carbamazepine sustained release tablet scaffold. A) CAD design of the tablet scaffolds with 2 configurations; B) Dissolution release profile of different configurations of tablet scaffold

Personalised Microneedle Eye Patch for Anti-Wrinkle Treatment

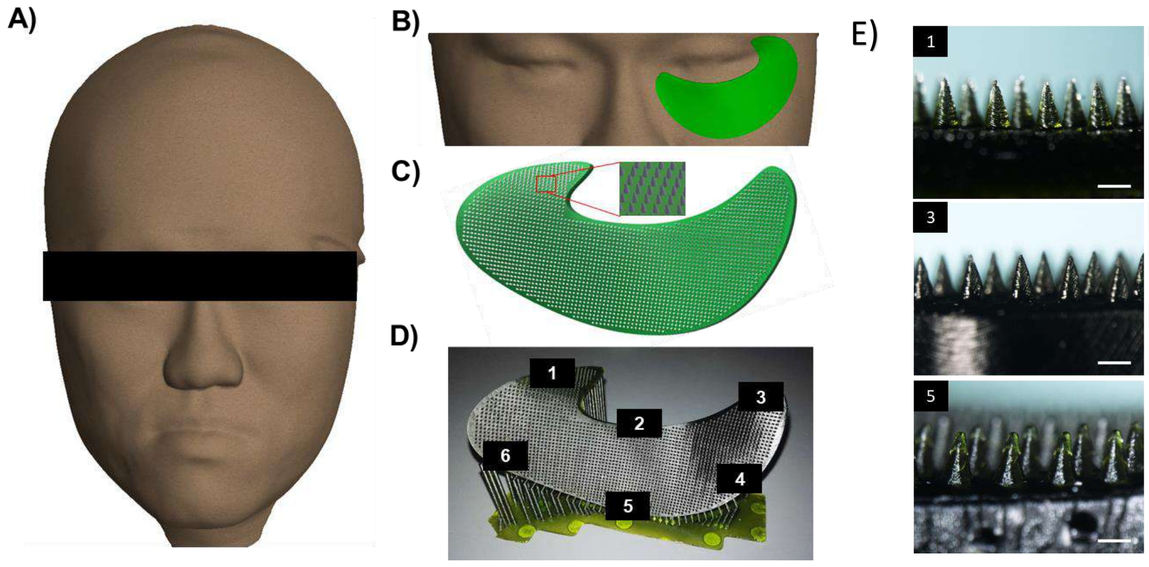


Figure 2: Summary of the development of personalised microneedle (MN) eye patch for delivery of anti-wrinkle small peptide A) CAD design of human volunteer face; B) CAD design with reverse engineering to create a contoured personalised eye patch; C) Personalised MN eye patch (PMNP); D) 3D printed PMNP; E) Series of microscope image for different section of the MN eye patch; F) *In vitro* skin permeation of different MN eye patch (PMNP demonstrated an almost 90X higher delivery as compared to commercial MN eye patch. All scalebars = 500 µm

Wearable Microneedle Splint For Trigger Finger

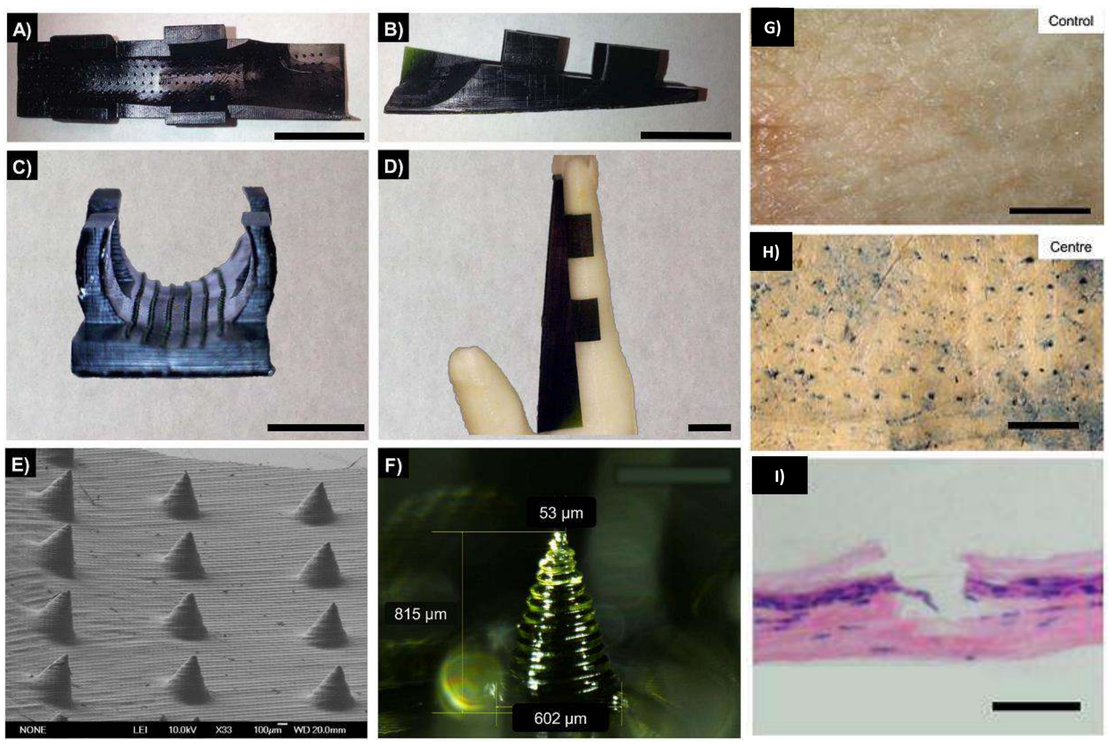
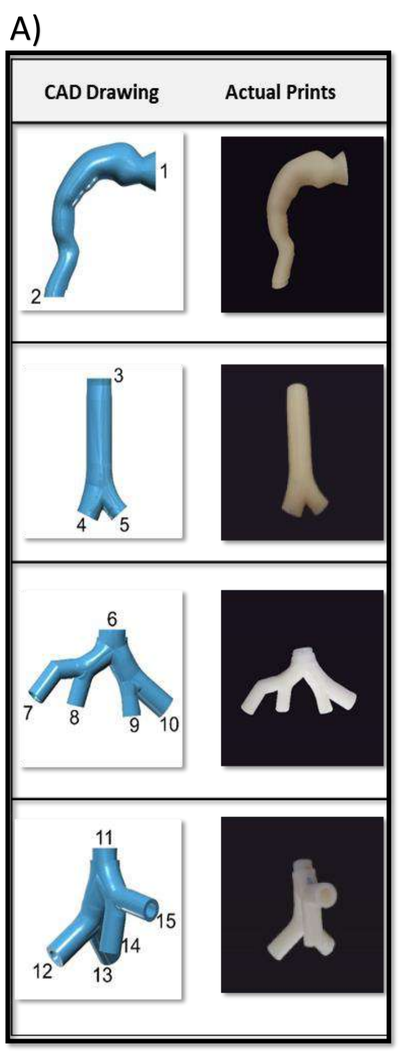
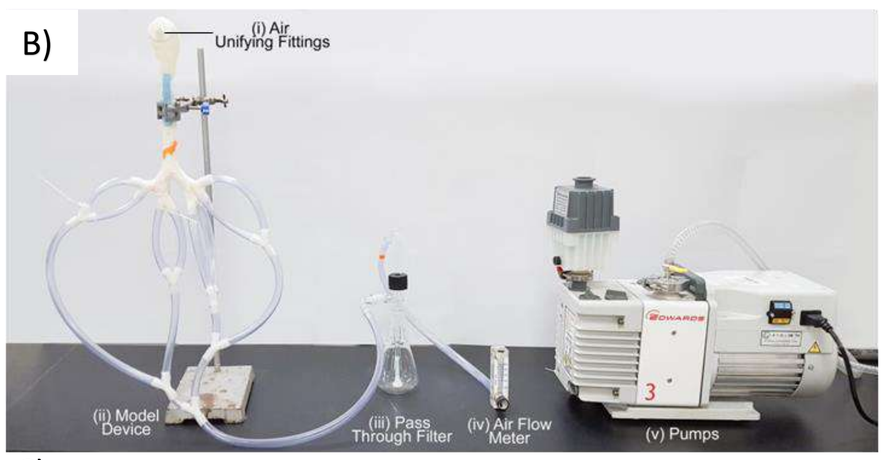


Figure 3: Summary of the development of wearable microneedle (MN) splint for delivery of diclofenac
A) 3D printed MN splint (Top) (scalebar:2cm); B) 3D printed MN splint (Side) (scalebar:2cm); C) 3D printed MN splint (Front) (scalebar:1cm); D) 3D printed MN splint fitted onto a hand (scalebar:1cm); E) SEM image of 3D printed MN splint; F) Image of a single MN; G) Intact Skin (scalebar:5mm); H) MN pre-treated skin (scalebar: 5mm), stained with trypan blue to indicate skin penetration; I) Histological sectioning of MN pre-treated skin to demonstrate successful skin penetration (scalebar: 50µm); J) In vitro skin permeation to demonstrate an enhanced delivery of diclofenac using MN splint, compared to without.

Human Respiratory Tract Model for Particulate Deposition Profiling





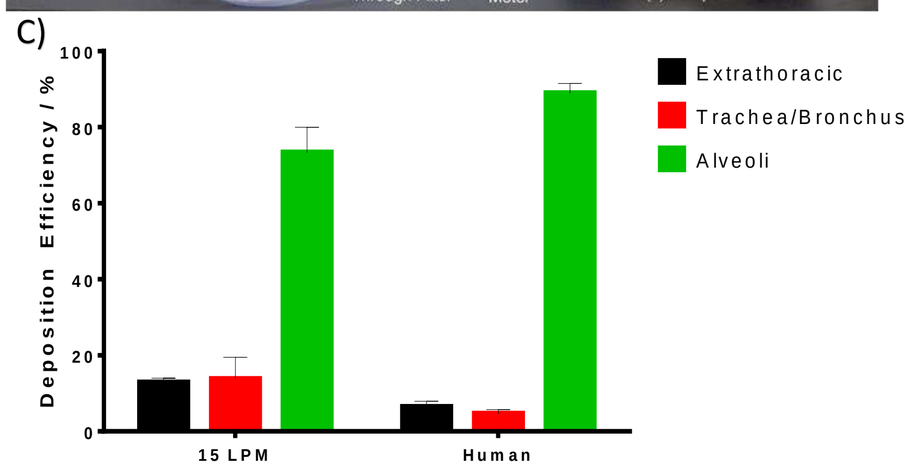


Figure 4: Summary of the development of human respiratory tract model for particulate deposition profiling. A) Image of the various CAD models of human respiratory tract (HRT) model obtained using CT images, versus the actual 3D printed parts; B) Entire setup for particulate deposition profiling, using the printed HRT model, connected to a pass through filter, air flow meter and a lab scale vacuum pump to generate air flow. C) *In vitro* deposition profiling at 15 litres per minute of airflow, compared to *in vivo* radiological data has no significant differences in the pattern of deposition.

Conclusion

3D printing is a useful technique to fabricate personalised drug delivery and testing systems. However, much work has to be done to establish the complete and long term safety profile of printed object and also the effect of 3D printing process on drug stability.