Fingerprints

June 2025

Table of Contents

Editors' Note

Kia ora colleagues,

This is the second edition for 2025. Thank you very much to Nick Taylor for writing a very interesting article on 3D- Printed splints! 🙂

If you have any material that you would like to share on Fingerprints, please send us an email at fingerprints@handtherapy.org.nz

Nico

Testing the Waters: 3D-Printed Splints in Practice

By Nick Taylor

Custom-made splints, created from 3D scans of the patient's body and produced using next-generation 3D printers, have the potential to advance splint quality and improve compliance within the hand therapy space. The practicality of day-to-day clinical use of this technology remains unclear however. To better understand the viability of introducing 3D printed splinting into daily clinical practice Body in Motion committed to a 12 month trial of the technology. This is a summary of our findings and my thoughts on what role 3D printing technology may play in hand therapy in New Zealand moving forward.

The Process

There are essentially five steps involved in the production of a splint:

1. 3D Scan

Given the splint will be modelled to a high degree of detail on the scan of the affected body part, it is critical that this be obtained in high fidelity. There are different methods to obtain this scan including:

1. Using multiple images taken from different angles using a standard phone camera (lower quality)
2. LiDAR (Light Detection and Ranging) scanning using appropriately equipped higher end phones (moderate quality)
3. Dedicated 3D scanning device such as the Structure Sensor (highest quality)

We opted to go for the Structure Sensor to ensure the highest degree of accuracy and best possible fit for the patient. The scanner is connected to an iPad running software from Spentys, one of a number of apps available in this space.

The scan is conducted with the patient resting their elbow on a table or support to reduce movement of the affected body part as much as possible. If the patient is unable to maintain a fixed angle at the joint or joints (such as in the instance of a tremor) it is possible to scan the contralateral and mirror the resultant model, however consideration must be given to presence of oedema, muscle bulk differences, or other factors that may introduce asymmetry.

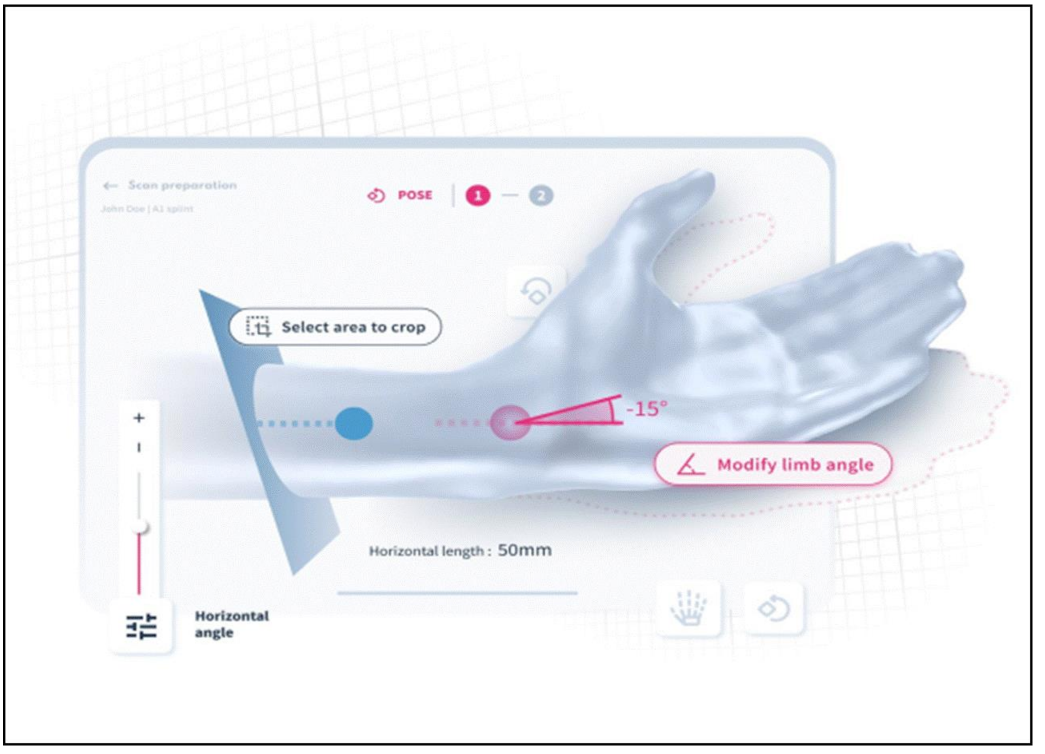
To conduct the scan the clinician holds the iPad with the scanner attached and walks essentially 360 degrees around the patient. Feedback is given by the software as to what surfaces have been captured and what remains to scan. Once the bodypart has been completely “painted” in the app, the scanning process stops.

The scanning process is quick, taking 30-60 seconds and is completely no-touch. This makes 3D printed splints a great option for patients with allodynia or heat sensitivity. In fact, our index case for this technology was a patient with severe CRPS who could not tolerate the warmth of pressure involved in provision of a thermoplastic splint. With this approach a highly ventilated padded resting splint could be provided with zero discomfort.

iPad with Structure Sensor attached.

2. Scan Correction

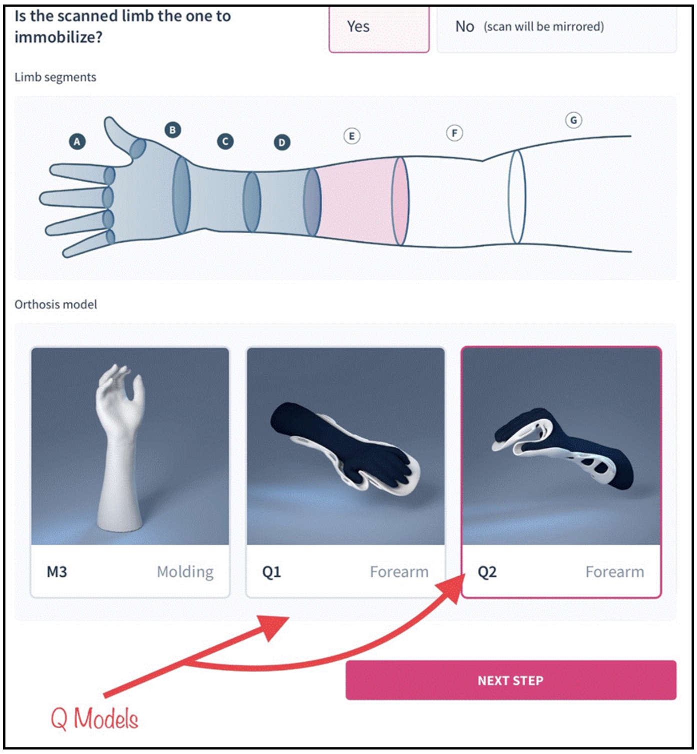
Once the scan has been checked for any missing surfaces or obvious aberrations (such as due to patient movement) it will need minor corrections applied. This is typically as simple as removing unwanted scan data such as the table the patient was resting on and the proximal forearm, or less frequently the joint angles may need to be adjusted. This is an interesting and potentially valuable feature as it can be used to position the patient in a way that they are unable to actively achieve. An example of this is following a suspension arthroplasty a patient was unable to maintain sufficient CMC joint extension during the scan. Data was captured in a suboptimal position but with use of this feature the CMC joint extension in the model could be manually increased. This led to a splint that held them in an ideal position. This feature could also be potentially used with serial splinting to gradually correct a contracture.



Cropping the scan and modifying wrist deviation angle.

3. Splint Design

The software offers a number of different splint models that can be applied to the scan. Once the desired model has been selected and applied, factors such as splint thickness, perforation pattern, etc can be fine tuned. There is also provision for adding attachment points for straps in the form of loops, rivet holes, or mushroom pins. Potential hotspots or pressure points can be raised away by a precise amount if desired, such as adding clearance at the ulnar head by an additional 1-2mm.



Selecting splint design based on body region.

4. Printing

Once finalised the 3D data file can be downloaded and either used to print the splint in house, or sent to an external printing company. We elected to use a local printing company that utilises an extremely high quality HP Multi Jet Fusion printer to produce smoothly finished, strong, durable splints. It is beyond the scope of this article to go into the myriad 3D printing technologies available, but suffice to say that care must be taken to select a printing method that produces skin-friendly finish. Many of the lower priced consumer-grade printers produce splint with visible and palpable layering effects that would reduce comfort and compliance.

Turnaround time from sending the data file to the company to receiving the printed splint would vary from 2-4 working days depending on their print schedule, with actual printing time in the order of 10 hours.

5. Post-printing finishing

Once the splint has been printed straps will need to be added and potentially edging materials applied. A combination of adhesive velcro and in-built loops and rivet holes was our preferred method for attaching straps. No further alterations should be needed at this point if the splint was well designed.

The patient would collect the splint from the clinic without needing a follow-up appointment or seeing a hand therapist due to the reliability of the fit, and ease of donning.

Total hand therapist time needed for provision of the splint including scanning, design, and finishing was 10-15 minutes, not dissimilar to that involved with a thermoplastic splint.

Finished splint with custom logo.

Considerations

Production Time

The turnaround time from scanning the patient to providing the splint is the primary drawback with 3D printing technology. For any patient where immediate support for a joint is required 3D printed splints are simply not viable. Now, printing times will decrease as the technology advances, but within-appointment printing of splints does not appear to be anywhere on the horizon at this point. Until splints can be printed in less than 5 minutes, thermoplastic and prefabricated splints will remain the status quo.

That said, there is a subset of patients, a relatively small but significant percentage, where a delay of a few days will not affect the outcome. Examples include:

- Patients who are in splints long term and require a replacement due to wear and tear
- Patients who are not tolerating a thermoplastic splint due to issues with maceration, poor fit due to pain during the moulding process, allergic reaction, etc
- Patients with acute injuries who are already in a support and for whom the tradeoff in leaving them in the temporary support and delayed provision of a 3D printed splint, versus immediate provision of a thermoplastic splint makes sense.
- Patients who are scheduled for surgery, and will require splinting during the post-operative period. These patients can be scanned during pre-operative period and the splint made ready to be fitted at the appropriate time post-op. Care obviously needs to be taken with regards to wound location, potential swelling, etc in these cases.

3D printed splints thus represent an outstanding option for a small percentage of patients at the current time.

Splint Modification

The ability to modify a splint once printed is another major drawback of this approach compared to thermoplastics. Heating and remolding is generally not possible, with adjustments being limited to trimming edges back with the use of a rotary tool such as a Dremel. And while it can be done, this process is not trivial, generating plastic shavings and a not inconsiderable amount of noise. The adjusted edge will need to be padded in most instances.

Fortunately the vast majority of splints fit perfectly without the need for adjustment. Approximately one in every forty splints required adjustment during our trial period.

Splint Quality

The overall quality of the splints provided to patients with this process was exceptional. They look good, feel good, and the patients loved them. The features most commented on by patients were:

1. Marked improvement in breathability. Due to the large perforations there is an immediate sensation of air against the skin compared to a standard perforated thermoplastic splint.
2. Improved aesthetics.
3. Lower profile. A 3D printed splint of 2.5mm thickness for example, will give similar support as a 3.2mm thermoplastic equivalent.

All patients who ended up wearing both a thermoplastic splint and a 3D printed one said that they preferred the printed one.

Splint Customisation/Branding

An interesting option afforded by this technology is that of adding custom decorative elements or branding to the finished splint. Embossing a company logo for instance is relatively easy to incorporate into the design process, adding an additional 2-3 minutes only, with there being plenty of scope to fully automate this.

Splint with custom logo for designer at Lower Clothing.

Geometric Freedom

There are implicit constraints in the thermoplastic splint fabrication process relating to the fact that a 3-dimensional object is being created by conforming a (functionally) 2-dimensional sheet. For instance it is not possible to create 360° support around the base of the proximal phalanx of the thumb without introducing a fold or seam, or to a fabricate a smooth spherical cap of uniform thickness. With 3D printed splints you are free from these constraints, and are able to utilise the potential of ground-up 3D spatial design. Variations in splint thickness, integrated fasteners, and lattice structures are all readily attainable, leaving therapists free to explore more innovative and expressive design possibilities.

Cost Analysis

3D printing software is often supplied using a subscription model, and this is the case for the Spentys app. Billing is performing as a fixed cost per month regardless of the number of splints provided. As such to be able to provide splints at a reasonable price a minimum number of splints needs to be provided per month. With our particular software contract, and with the printing method we used, it ended up that roughly 7 splints per month needed to be provided to keep splint pricing reasonable and to cover production costs.

With this pricing model, considering the relatively small percentage of patients for whom type of splinting is appropriate, smaller hand therapy clinics may not produce sufficient splints to cover costs. If access to software could be obtained on a per-splint basis however this would change viability, and potentially make it a more realistic option for these smaller clinics.

Closing Thoughts

The quality of 3D printed splints that are correctly designed and printed is exceptional, and consistently receive superior feedback from patients compared to their thermoplastic equivalents. Production time, however, remains the primary issue. Printing times will come down as the technological advances occur, but the gap between where we are at now and what would be needed for in-appointment production of the splints is so large that it is difficult to envisage thermoplastic splints being deprecated any time soon. In fact it remains to be seen whether an entirely new splinting technology will emerge before print times reach in-appointment level, relegating 3D printed splints as a near-miss technology in the hand therapy space.

For now I consider these splints borderline feasible for New Zealand hand therapy clinics, with clinic size, patient types, local 3D printing options, and software subscription options making or breaking the option for any given company.

Educational opportunities

Below are a series of resources for educational purposes that the HTNZ Education committee and us have identified in the last period. You can also keep an eye out for updates on the HTNZ blog page.

Online Journals

Hand Therapy New Zealand offers access to several fantastic journals. If you haven't already done so, head over the Journal page and try accessing any of the resources available (e.g. Journal of Hand Therapy). If you do not have a log in, contact admin@handtherapy.org.nz to receive a unique login code. The benefit of having access to these journals is that if you find an article on HandyEvidence that you like or you just want to search for information in the journals, you can often access the full text.

Anatomy Standard

This resource contains anatomy images, which are free to reproduce for non-commercial use. You can access Anatomy Standard online and cruise through several upper limb anatomical layers. Thanks to Tom Adams from AUT who pointed this resource out.

HandyEvidence

Nico's website reviews and assesses three clinically relevant scientific articles on Hand Therapy every week. In addition, it contains a database of over 650 previous synopses searchable by topic and level of evidence. It has been sponsored by HTNZ for 2024 for all New Zealand Hand Therapists.

Consent for clients' information and images

HAND THERAPY NEW ZEALAND
Ringaromi Aotearoa

Consent form – use of clinical case information and images

I, (*patient's name:* ______________________________) consent to the use of information and images including photographs or videos from my hand therapy assessment and treatment to be used for (*mark agreement by clicking on box or print and tick*)

- ☐ Educating clinicians relevant to hand therapy
- ☐ Educating clinical students
- ☐ Service audit
- ☐ Publication in professional or scientific journal

I understand that the information and images will not have my name attached to them and will not obviously identify me in any way.

Patient Details:

Name: ____ Tel: ____________________

Email: ____

Signed: ____________________________________ Date: Click or tap to enter a date.

Clinician Details:

Name: ____ Tel: ____________________

Email: ____

Organisation: ____

Hand Therapy New Zealand membership ☐Full ☐Associate Membership No. ________

Signed: ____________________________________ Date: Click or tap to enter a date.

Consent form case study final 15/02/2021

You can download the original document on HTNZ webpage.