Breakout Session B5

B5.A: Using foam carve seating with anterior contouring for clients who rotate out of their lateral support – two case study

James Hollington and Catherine Robertson

The aim of this presentation is to present two case studies where foam carve seating has been used to provide not only lateral but also anterior support in order to reduce the need for tilt and harnessing. The case study outcomes will be presented and discussed to share learning and clinical experience.

Custom contoured seating is most often reserved for service users with the most complex musculo-skeletal deformation. Primary discussion prior to embarking on the provision path post assessment considers other possible service interventions: surgery, medication, orthotic spinal braces. However, when these options are exhausted custom contoured seating is often called upon to achieve extremely demanding goals. One of the most difficult to accommodate is lateral spinal flexion (scoliosis) combined with trunk rotation and anterior spinal flexion (kyphosis). Often harnessing for anterior chest support and extreme tilt for the assistance or gravity are employed in an attempt to manage this.

The case studies to be presented indicate that anterior foam carve support can be provided within custom contoured foam carve seating systems to more effectively support rotating kypho-scoliotic postures than harnessing and extreme tilt.

Service user clinical presentations will be presented, and casting techniques will be briefly discussed. Reasons why harnessing and tilt were deemed not to be effective, and why alternative anterior support was explored, will be described, and resultant outcome presented.

B5.B: 3D printing for customised postural support devices

Dr Sarah Greasley

During my elective on the Scientist Training Programme I was involved in a project with Motivation to investigate 3D printing as a new technology to produce customised postural support devices (PSDs). A trial was performed in Bangalore at the Association for People with Disabilities, and the outcomes were evaluated.

Aims and Objectives

Assess whether the 3D PSD printing concept is viable overseas:

- Capture the correct clinical and technical data to create individual PSDs
- Can the PSD generating process be carried out technically in a robust way?

Assess function of PSDs over time:

- How closely do the PSDs support the final posture achieved in manual simulation?
- How comfortable do service users find the new supports?

How satisfied are users with the service provided?

Background
Preliminary studies have suggested that 3D printing can be used very successfully as a low cost solution for the manufacture of orthoses (Dombroski, Balsdon and Froats, 2014) and even prosthetic sockets (Herbert et al., 2005). Foot orthosis companies have begun to capitalise on this (podfo®, 2018). However, the technology has yet to be utilised for customised PSDs in wheelchairs and other forms of seating. This project aimed to assess whether 3D printing customised PSDs was a viable concept.

Motivation has developed a dimensional information measurement system (DIMS) to take accurate measurements in 3D space. This can be used to take meaningful clinical measurements of patients in order to create and locate customised 3D printed PSDs. A shipping container was set up with an assessment bench, DIMS and two 3D printers. Testing in the UK was conducted in 2016 and, in June 2017, the container was sent to Bangalore. Two local clinicians were trained to use the new processes, and 15 initial participants were assessed using the new methods, including follow-ups at 1 week, 1 month and 3 months.

Feedback was obtained in the form of follow-up questionnaires at each stage, and any necessary adjustments to the PSDs were recorded. It was found that participants were very happy with the service and product that they received. Problems were highlighted such as being unable to fold the chairs, although this was addressed by new CAD designs for removable PSDs. This is one of the major advantages of 3D printing on-site. Overall, 3D printing was concluded to be a reliable manufacturing method, using local materials, with a 92.6% success rate. Power outages were responsible for the majority of failed prints. Local clinicians were able to select appropriate PSDs from an online library, and then make simple alterations to CAD files to produce customised supports. However, the majority of design was still conducted by international engineers during this initial trial.

An evaluation into the DIMS measurement system was also conducted and both inter and intra clinician reliability was tested. The results showed a relatively significant degree of variation, with ranges of up to 50mm for some dimensions. This would need to be understood and addressed before rolling out the system further. However, local clinicians found the process useful to guide their thinking.

Finally, a direct comparison of the old method of manufacture/assessment with the new 3D printing method was conducted for four additional participants. This was necessary in order to ascertain the specific benefits related to 3D printing. Patient feedback was positive for both types of modifications, although the 3D printed PSDs had better feedback in terms of comfort and support. Further details of these four participants were written up as individual case studies. The time taken to complete the assessment/manufacture process was a very difficult parameter to assess, due to a large number of variables and small numbers of participants. There were no significant findings, other than, when asked in interview, local clinicians preferred the 3D process.

Discussion
This project successfully used 3D printing to create customised postural support devices with positive feedback. The container has subsequently been left at the Association for People with Disabilities for a further six months in the hands of local clinicians, with support where required. The feedback will provide a valuable insight into how such a system might integrate with an existing wheelchair service.

However, the degree of customisation was limited. In order to speed up the product delivery for patients, a stock of commonly used 3D printed PSDs was kept and, in most cases, personalisation was achieved by the selection of stock parts by clinicians based on DIMS measurements. It would be interesting to discuss whether the current degree of customisation necessitates 3D printing, and how further customisation could be achieved.

Another interesting point of discussion would be whether there is a place for the 3D printing of customised PSDs or the DIMS measurement system in the UK. With more established supply chains and adjustable wheelchairs it may not offer the advantages that it does in a more remote setting. However, the technology could also be used in many ways. The 3D printed PSDs are certainly a very neat solution to postural management and the hip pads in particular could fill a gap in the UK market.

References

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B5.C: Manufacturing custom-contoured wheelchair seating - a state of the art review

Susan Nace

This presentation will detail a state-of-the-art review of the current manufacturing processes used to produce custom-contoured seating systems for wheelchairs.

The purpose of this review is to assess the strengths and weaknesses of the current manufacturing methods and materials used in custom-contoured wheelchair seating systems. With this information, alternative means of manufacturing are suggested to resolve existing issues in seating, specifically the high temperatures and moisture levels prevalent with custom foam seating systems that increase the risk of pressure injury in users.

Background: Custom-contoured seating systems were initially developed in the 1960s to accommodate young wheelchair users with cerebral palsy, spina bifida, and other physical disabilities requiring postural support (Watson and Woods, 2005). Today, custom-contoured seating has proved to be key in aiding the development of motor skills (Green and Nelham, 1991), preventing spinal deformities (Pountney et al., 2002), and in supporting postural stability such that limb mobility and communication are eased in users of all ages (Neville, Quigg and Armstrong, 2005). It is also vital in addressing and preventing pressure injury in full-time wheelchair users. Lowering maximum pressures in weight-bearing areas has been shown to lower the risk of pressure injury (Barbenel, 1991). Custom-contoured seating systems achieve this by enveloping the body and increasing the area over which weight is distributed (Tasker et al., 2014).

However, the majority of custom-contoured seating today is made of foam, an insulator. Thus, the temperature and moisture level at the user-seat interface increases the longer a person is seated in their seating system. High temperatures and moisture levels increase the rate of tissue breakdown, thus increasing the risk of pressure ulcer development (NPUAP, 2014). Knowing these issues exist in most custom-contoured seating options, further assessment on the strengths and weaknesses of custom-contoured seating and production options was conducted.

Technique: This state-of-the-art review was completed through research of current and past literature related to custom-contoured seating and pressure redistribution, as well as through interviews with relevant stakeholders, i.e. custom seating users, occupational therapists, physiotherapists, seating technicians, and other persons in the custom seating field.

Results and Testing: Five manufacturing methods are currently used to produce custom-contoured seating systems. These are: foam-in-place seating (FIPS), plaster moulding, drape forming of moulded seat inserts (MSI), manually-adjustable micro-modular seating (AMMS), and CNC foam carving. All of these methods except AMMS produce foam seating, and increased temperatures and moisture levels are issues common to all types of foam custom seating. AMMS seating systems maintain cooler seat and tissue temperatures, but their high rigidity, weight, and cost make them inappropriate for some wheelchair users. Plaster casting using poured foam, the main technique used at Enable Ireland's SeatTech facility, is materially inexpensive but requires high manual labour to produce. CNC foam carving, on the other hand, is highly automated and so needs little to no manual labour, and does not need physical storage space like plaster casting requires. CNC foam carving, however, produces high material waste and has significant start-up costs, including the machine and operator training.

The major limitations in custom foam seating are high temperatures and moisture levels in the seat, high manual labour requirements, and the need for large amounts of physical storage space. The high temperatures and moisture levels present at the seat surface increase the risk of pressure injury in users, which should be avoided as pressure injury is painful, costly, and can be fatal in some users. The high manual labour requirements and amount of storage space needed to produce plaster cast foam seating systems make for an expensive and inefficient manufacturing process. Instead of investing in CNC foam carving, which would lead to an increase in material waste and would not solve the issues of temperature and moisture at the user-seat interface, a new manufacturing route could be developed to produce custom-contoured seating.

Additive manufacturing through 3D printing has already shown promise as an efficient manufacturing process for custom parts, including prototype wheelchair parts and accessories (Hudson, 2016; Smith, 2016). Manufacturing custom seating through 3D printing would minimise the need for physical storage space since the process would use digital storage, like CNC foam carving uses. It would also enable more control over the microclimate at user-seat interface; minimising the foam in a final custom cushion would lower the temperatures experienced by users and lower moisture accumulation at the interface. Although prototypes have shown that 3D printing is capable of making parts of wheelchairs, its feasibility as a manufacturing process for custom-contoured wheelchair seating systems requires further investigation.

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