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Technical note

ISO 16840-2:2007 load deflection and hysteresis measurements for a sample of wheelchair seating cushions

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ABSTRACT

Load deflection and hysteresis measurements were made on 37 wheelchair seating cushions according to ISO 16840-2:2007. Load deflection plots for all 37 cushions are reported and fundamental aspects of graph interpretation discussed. ISO hysteresis data are also reported and interpretation discussed.

1. Introduction

Wheelchair seating cushions must fulfil a variety of requirements to meet an individual's specific rehabilitation aims, including managing comfort, tissue integrity, postural control, postural alignment and functional enablement. Clinical selection of the best seating support surface however continues to be based principally on custom and practice, the individual clinician's experience, seating theory, user trial and, if available, interface pressure mapping. The reason for this must be, in part at least, the lack of evidence available to guide prescription [1].

The evidence required to facilitate more objective prescription of cushions includes detailed information about the intended user's diagnosis, associated physical and cognitive complications, other aspects of their health, postural presentation, ability, lifestyle, environment, and rehabilitation goals. There is also however a need for objective information about the performance of the available cushions.

Several measures have already been defined and some are in use. Kuncir et al. [2] for example describe compliance factor and compressibility factor. Other measures are from the furniture industry, such as indentation force deflection [3]. Some manufacturers of wheelchair seating cushions also provide information on specific products. Qbitus Products (Halifax, UK) for example, publish Linear Load Limit. Invacare (Elyria, OH), by contrast, publish Loaded Contour Depth, Overload Deflection and Impact Damping data [4], which are defined in the ISO 16840-2:2007 standard [5], for cushions in the Flo-tech range. Other manufacturers however do not provide any objective measures at all. The paucity and inconsistency of data therefore makes rigorous comparison of cushions difficult or impossible.

ISO 16840-2:2007: Wheelchair seating—Part 2: Determination of physical and mechanical characteristics of devices intended to manage tissue integrity—Seat cushions, was published in 2007. Standards are important as they can facilitate the production of transparent data that can be globally understood, allowing objective comparisons of products. This can increase the safety, quality

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and reliability of design and hence provision, and means manufacturers cannot make unsubstantiated claims. ISO 16840-2:2007 is the first version of this standard and was current at the time of testing. A revision however is in preparation at the time of writing.

ISO 16840-2:2007 details a set of measures which describe static and dynamic/elastic characteristics of wheelchair seating cushions which are relevant to tissue integrity. Tests are accompanied by rationale linking each test to clinically relevant features of cushions such as pressure redistribution and shock absorption. In its introduction the standard also states, "The link to clinical efficacy, although implied, has not been validated," and goes on to express the intention that, "this part of ISO 16840 will evolve when the evidence of clinical relevance is confirmed." The emergence of this evidence however is unlikely unless the standard and its resulting data are familiar to and better understood by clinicians. Although the standard was not developed for clinicians to apply directly in clinical decision making, it is hoped that this Technical note will begin the process of developing better understanding amongst clinicians, and hence may lead to theories of clinical effectiveness which draw upon their valuable experiential knowledge.

The aim of this study therefore is to begin this process by examining the results from one of the tests for a selection of wheelchair seating cushions with a view to identifying aspects of the data most salient to differentiating the cushions according to clinical potential. The test examined in this study is the load deflection and hysteresis test described in section 9 of the standard, and which considers the compression characteristics of the cushion as it is loaded and unloaded.

2. Method

Load deflection and hysteresis measurements were made on 37 wheelchair seating cushions according to section 9 of ISO 16840-2:2007 [5]. For full details of test procedures please refer to section 9.2 of this standard.

The cushions tested are listed in Table 1. The cushions represented a variety of manufacturers' designs in current clinical use and also a range of foam types used in custom-made wheelchair seating systems. Cushions were 410 mm wide by 460 mm long where available, which was the size judged to be most appropriate to fit the experimental apparatus, i.e. the rigid cushion loading indenter (RCLI) specified in Annex A of the standard. Where this size was not available, the closest available size was used.

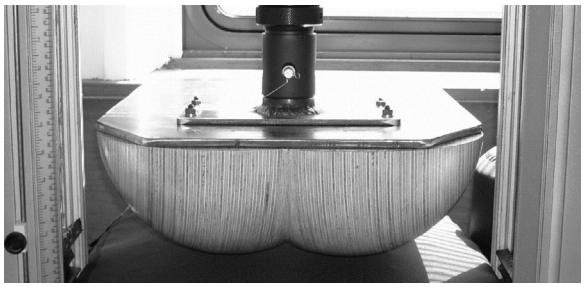

Fig. 1. Rigid cushion loading indenter (RCLI).

The load deflection and hysteresis test requires that each cushion is loaded with an RCLI, which is a rigid representation of human buttocks and thighs (Fig. 1). The thickness of the cushion is measured as the difference between the height of the RCLI top surface with and without the cushion on the test surface. Thickness measures are made when the RCLI is loaded onto the cushion at 8 N, 250 N, 500 N and 750 N as the load is increased and 500 N, 250 N and 8 N as the load is decreased. The cushion is allowed to equilibrate at each load for 120 s ± 10 s before each measurement is taken. The test is repeated three times for each cushion. An Instron 5567 mechanical testing machine (Instron, High Wycombe, United Kingdom) was used to apply these controlled loads and data were collected with Instron Merlin software. Reported values are the means of the three measurements as required by section 9.3 of ISO 16840-2:2007 [5].

ISO 16840-2:2007 does not distinguish between different designs of cushion. This means that the same method was used

Table 1
Cushions.

Cushion	Construction	Cushion	Construction
Roho single valve[a]	Single compartment, cellular air filled	Propad[c]	Planar foam, single layer
Roho Quadtro[a]	Multi-compartment, cellular air filled	50 mm V33 polyether[f]	Planar foam, single layer
Jay J2[b]	Contoured foam, single layer with viscous fluid overlay	75 mm V33 polyether[f]	Planar foam, single layer
J2 Deep Contour[b]	Contoured foam, single layer with viscous fluid overlay	50 mm CM60	Planar foam, single layer
Jay 3 with Roho[b]	Contoured foam, single layer with cellular air filled insert	75 mm CM60	Planar foam, single layer
Jay Gel[b]	Contoured, gel and foam dual layer	50 mm CM35	Planar foam, single layer
Flo-tech Contour[c]	Contoured foam, single layer	75 mm CM35	Planar foam, single layer
Flo-tech Contour Visco[c]	Contoured visco-foam, single layer	50 mm RX39	Planar foam, single layer
Flo-tech Plus[c]	Contoured foam, single layer with viscous fluid insert	75 mm RX39	Planar foam, single layer
Flo-tech Solution[c]	Viscous fluid sacks overlaid on contoured foam	50 mm Pink viscose	Planar foam, single layer
Flo-tech Lite[c]	Contoured foam, single layer	75 mm Pink viscose	Planar foam, single layer
Flo-tech Lite Visco[c]	Contoured visco-foam, single layer	50 mm Sunmate[g] soft	Planar foam, single layer
Varilite Evolution[e]	Triple foam construction, contoured by air evacuation	75 mm Sunmate[g] soft	Planar foam, single layer
Qbitus Mercury 100[h]	Contoured foam, dual layered	50 mm 3lb chip	Planar foam, single layer
Qbitus Mercury 200[h]	Contoured foam, dual layered	50 mm 6lb chip	Planar foam, single layer
Qbitus Mercury 300[h]	Contoured foam, dual layered, with gel-foam insert	75 mm 6lb chip	Planar foam, single layer
Qbitus Qbi-gel	Planar, gel and foam dual layer	25 mm Pink viscose on 50 mm 3lb chip	Planar foam, dual layered
Vicair Adjuster 6[d]	Air sacs in multi-compartmental cover	25 mm Sunmate[g] soft on 25 mm CM35 on 25 mm CM60	Planar foam, triple layered
Vicair Adjuster 10[d]	Air sacs in multi-compartmental cover		

[a] The Roho Group, Belleville, IL.
[b] Sunrise Medical, Boulder, CO.
[c] Invacare, Elyria, OH.
[d] Vicair, Wormer, The Netherlands.
[e] Varilite, Seattle, WA.
[f] Vitafoam, Manchester, United Kingdom.
[g] Dynamic Systems Inc., Leicester, NC.
[h] Qbitus, Halifax, United Kingdom.