3D SURFACE SCANNERS IN SPINE CLINIC: A PILOT STUDY TO ASSESS SCANNER ACCURACY

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INTRODUCTION

The externally visible deformity, in terms of rib hump, shoulder and hip asymmetry and anterior rib asymmetry, is usually the first symptom observed by adolescent idiopathic scoliosis (AIS) patients. Often these cosmetic factors remain the primary concern for patients. Presently, AIS deformity is assessed clinically from standing X-rays using the Cobb angle, the magnitude of which does not correlate well with external appearance or post-surgical satisfaction. Torso rotational deformity (rib hump) is currently assessed by laying a goniometer across the patient's back while they bend forward (1). Whilst rapid, this test does not fully encompass all elements of the deformity and fails to address the areas of most cosmetic concern to the patient.

A non-invasive assessment method capable of capturing details of the superficial anatomy of the patient, including surface features of the anterior and posterior torso, would enable better qualitative and quantitative evaluation of improvements in patient cosmesis following surgery. Non-contact, handheld 3D scanners are capable of rapidly capturing high resolution 3D scans of surface anatomy in a clinical setting. There is a large array of scanners available on the market with substantial variations in price, scanning volume and most importantly, accuracy. A necessary initial step in introducing such technology into a clinical setting is to evaluate their performance against clinically-relevant measures. This study aimed to quantify the accuracy, repeatability and user experience of three of the most commonly available scanners, in assessing posterior asymmetry for AIS patients.

METHODS

Eight plaster cast moulds which had been manufactured to create braces for AIS patients were selected as test cases for this study. These brace casts have previously been used in the assessment of the iPhone as a Scoliometer substitute, and so have a known rib hump measurement (2).
Four scanners were chosen for inclusion in this study:

1.	Solution X scanner (Sol X)	$60 000
2.	Artec Eva (Eva)	$25 000
3.	Microsoft Kinect V1 (K1)	$250
4.	iPhone with 123D Catch app	$0 (+ iPhone)

The Sol X scanner is a state of the art metrology scanner with sub-micron accuracy. This bench top scanner is not suitable for a clinical environment as it scans a small fixed region of interest on an inbuilt turn table. Surface scans from the Sol X provided a 'Gold Standard' reference for the geometry of each cast. Rib hump measurements for each cast (2) served as a clinical comparison.

Each cast was scanned with the Sol X using an automated process; and then with each of the other scanners. The surface information from each scan was processed to create a virtual model of the AIS cast and from these models; a simulated rib hump measurement was obtained. The surface models obtained with each scanner were also registered to determine the deviation between the scanned surfaces at specific locations across the casts.

RESULTS AND DISCUSSION

Surface to surface deviation maps for each of the scanners showed excellent agreement between the Sol X and the Eva with deviations of 0.05 ± 0.10mm (mean ±SD) (Figure 1). The K1 and iPhone showed much lower agreement, with the K1 at 1.63 ± 1.90mm and the iPhone 2.07 ±1.58mm relative to the Sol X.

Rib hump measurements are currently all within 2° of each other and not more than 1° higher than the value measured directly from the casts (2). These deviations are lower than clinical measurement variability.

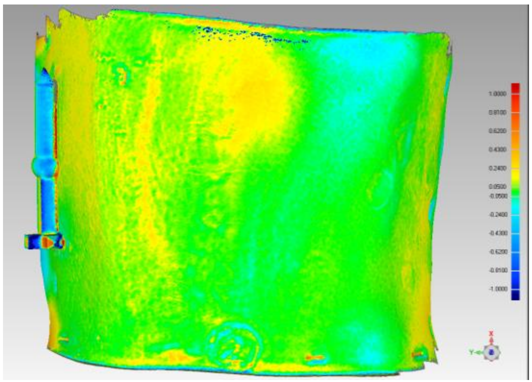

Figure 1. Torso surface deviation map between the Solution X and the Artec Eva scanners, colour bar is between +1mm (red) and -1mm (blue)

CONCLUSIONS

While the analysis of this dataset is ongoing it is envisaged it will provide important insights into the utility of commercial surface scanners in a clinical setting. Despite enormous variations in price, the accuracy of the scanned deformity was comparable to routine clinical measures. This study presents pilot data to select a suitable scanner for use in future research into AIS progression.

REFERENCES

1. Adams W: Lectures on the pathology and treatment of lateral and other forms of curvature of the spine London: Churchill; 1865.
2. Izatt, et al. Evaluation of the iPhone with an acrylic sleeve versus the Scoliometer for rib hump measurement in scoliosis (2012) Scoliosis, 7(14).