CORRELATION OF EXTRINSIC INDICATORS IN CHILDREN SUFFERING FROM IDIOPATHIC SCOLIOSIS

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Introduction

Scoliosis is a highly complex 3D disorder of the spinal column that affects some 6-8% of the global population. Almost 80% of the cases in children are of unknown origin (i.e. idiopathic) [1]. The main drawback of traditional diagnostic methods for the assessment of spinal deformities is the inherent invasivity, especially due to multiple exposures to radiation (e.g. X-rays, CT.) [2]. In addition, these methods require high-quality imaging, as well as reliable positioning of the patient in order to ensure accurate measurement of key clinical parameters of the deformity. The aim of the study is to investigate the level of correlation degree between certain dorsal indicators of the optical surface scans to better understand nature of scoliosis and posture.

Methods

The population comprised 372 adolescent patients with idiopathic scoliosis (141 male patients (28.5%) and 231 female patients (46.7%)) with valid optical scans of dorsal surfaces recorded between 2008 and 2013 [2]. We performed a systematic evaluation of the patients' data, including: 3D optical scanning and reconstruction of the patient's dorsal surface; development of a generic 3D spinal model based on a series of CT slices (in Mimics 18.00, Materialise, Belgium); surface and curvature analysis (in PLM system CATIA, Dassault Systemes), and implemented knowledgeware technologies for extracting important intrinsic and extrinsic deformity indicators, together with the 3D visualization of the deformity, noninvasively (Fig.1).

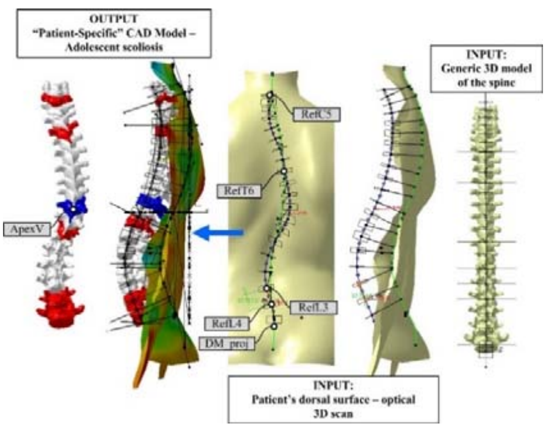

Figure 1: Patient specific model of the spinal deformity

For this study we focused primarily on external indicators: TL-VPDM (Trunk Length - VPDM), TL-VPSP (Trunk Length - VPSP), DD-DLDR (Dimple Distance), TIn-VPDM (Trunk Inclination), TI-VPDM (Trunk Imbalance), PT-DLDR (Pelvic Tilt), CL (Cervical Lordosis), LL (Lumbar Lordosis).

Results

The system was able to calculate all measures of dorsal indicators with minimal human intervention in a repeatable manner. Pearson's correlation of the certain external parameters is given in matrix table (Tab.1). Correlation analysis revealed relatively high Pearson's coefficient between lumbar lordosis (LL) and trunk inclination (TIn-VPDM) in sagittal plane.

	TL-VPDM	TL-VPSP	DD-DLDR	TIn-VPDM	TI-VPDM	PT-DLDR	CL	LL
TL-VPDM	1	$.96^{**}$	$.32^{**}$	$.21^{**}$	$-.22^{**}$	.08	$.26^{**}$	.01
TL-VPSP	$.96^{**}$	1	$.35^{**}$	$.22^{**}$	$-.23^{**}$	.06	$.27^{**}$	.00
DD- DLDR	$.32^{**}$	$.35^{**}$	1	-.04	-.07	.01	$.15^{*}$	$.2^{**}$
TIn-VPDM	$.21^{**}$	$.22^{**}$	-.04	1	-.10	.03	$.36^{**}$	$-.7^{**}$
TI-VPDM	$-.22^{**}$	$-.23^{**}$	-.07	-.1	1	$-.23^{**}$	-.07	.06
PT-DLDR	.08	.06	.01	.03	$-.23^{**}$	1	-.10	.01
CL	$.26^{**}$	$.27^{**}$	$.15^{*}$	$.36^{**}$	-.07	-.10	1	$.17^{**}$
LL	.01	.0	$.20^{**}$	$-.7^{**}$	.06	.01	$.17^{**}$	1

Yellow – very high, Red – relatively high, Green – low, Purple – very low correlation

Table 1: Pearson's correlations of specific dorsal indicators for 372 patients

Discussion

We proposed a non-invasive 3D methodology to quantify deformity measures using patient-specific models generated from patient's dorsal shape, and anatomical landmarks. Statistical analysis demonstrated a relatively high correlation between a number of external parameters in the context of anatomical landmarks (Vertebral prominence – VP/C7 and Middle Dimple Point), particularly among sagittal indicators.

References

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Acknowledgements

Described research is supported by the Serbian Ministry of Education, Science and Technological Development under the grant III-41007.