ANTHROPOMETRIC CHARACTERIZATION OF SPLEENS AND KIDNEYS IN CHILDREN

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INTRODUCTION

The detailed geometric characterization of children's internal organs is still unknown, but such knowledge is required in order to improve the biofidelity of models used in car crash simulations [1]. Many dimensions have been measured by ultrasonography, but these have given only 2D mesurements. In addition, there were biases depending on the operators and the patient position [2]. This paper presents two complementary studies focused on the anthropometric characterization of the spleen and the kidney in children.

METHODS

For each spleen and kidney organ study, 30 children's CT-scans were collected from two hospitals' databases, both of which had children's traumatic intensive care units. The age range of the subjects was from 2 to 16 years old for the spleen study and from 2 to 12 for the kidney study. Exclusion criteria were: age above 16 years old (when the organs have matured), spleen or kidney lesion, abdominal visceral lesion suggesting a change in its external morphology, inflammatory or chronic infectious disease, and neoplasm with abdominal metastases.

MIMICS® (Materialise Software®, Brussels) was used for numeric modeling of these organs in three dimensions (Figure 1). Various 3D measurements were defined and performed to characterize the intrinsic organs' geometry and to determine the relationship between organ growth and the skeleton.
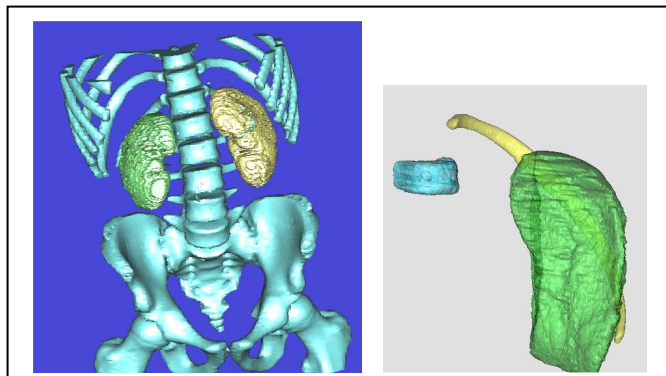

Figure 1: 3D model of a child's kidneys and spleen in the osteoarticular system.

An intraoperator and interoperator reproducibility investigation was carried out to estimate the validity of the measurements. Statistical analysis was performed to evaluate the influence of the laterality (for kidneys only), the gender and the age for all measured parameters. A descriptive analysis was conducted for each measurement in order to determine an "average" organ model for different age groups.

RESULTS AND DISCUSSION

The reproducibility study was conclusive: a very low systematic deviation of 0.3 cm^3 was observed. Some kidney measurements tended to be higher in the female population, but no significant difference was found between female and male subjects on any measured parameter. A child's growth had a significant effect on the geometry of the kidney and its position in the osteoarticular system. Significant correlations between kidney size and specific bone dimensions were observed (e.g., the renal volume and the inter-cephalic distance were correlated). The renal volume grows linearly with age (Figure 2), whereas the development of the spleen begins in puberty (Figure 3).
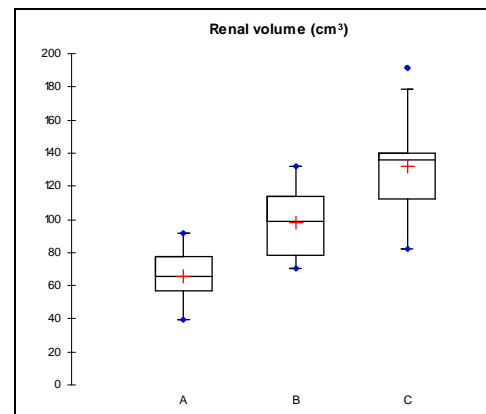

Figure 2: Renal volume according to age (A: age 2-6; B: 7-9; C: 10-13); 20 samples in each age category.
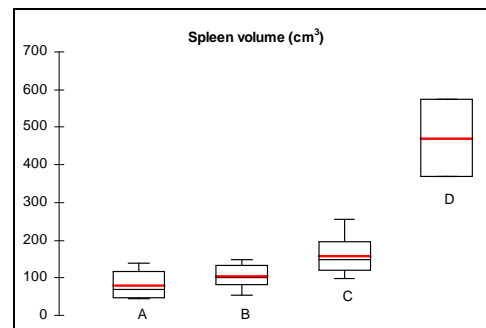

Figure 3: Spleen volume according to age (A: age 2-5; B: 6-9; C: 10-12; D: 15-16). Number of samples – A: 5; B: 9; C: 14; D: 2.

CONCLUSION

This preliminary study presents a validated measurement protocol based on 3D reconstructions and provides first measurements and descriptions of child spleen and kidney during growth. It will be extended to other internal organs, including the liver, lungs, and heart. A larger population would have strengthened the results.

ACKNOWLEDGEMENTS

REFERENCES

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2. Michel SC, et al. *Eur Radiol.* **14**:1508-1512, 2004