Generalized Factor Analysis of Dynamic MR Urography

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PURPOSE: We investigate an automatic method of analysis of dynamic MR Urography (MRU) for extraction of distinct physiological compartments.

METHODS: We used factor analysis model to represent temporal changes in pixel amplitudes as a linear combination of finite number of factors [1]. Three factors in this study were used to represent different functional units of the renal system: cortex, medulla, and collecting system. Factors and factor images were estimated by performing non-negative matrix decomposition of dynamic data and then impose non-uniqueness constraints using minimum overlap principle [2, 3]. Five pediatric urology patients (ages two months to seven years) underwent contrast-enhanced dynamic MRU using coronal T1-weight fat-saturated VIBE sequences for the evaluation of hydronephrosis. Each patient had one normal kidney and one abnormal kidney. Factor analysis was applied to each kidney separately.

RESULTS: Expected time-behaviors for normal kidney were obtained with clear separation of different physiological regions. Of five abnormal kidneys, two of them had ureteral obstruction; one had renal pelvis dilatation without obstruction, one had primary megaureter, and one had a duplex kidney with a completely nonfunctioning upper pole moiety and normal lower pole moiety. The distributions of tissue dysfunction represented by factor images obtained in this study were consistent with respective underlying obstructive versus non-obstructive pathology. (Figure)

DISCUSSION: The method can be applied in daily clinical setting for detection and characterization of kidney function using MRU because it only requires a minimal user input. Future work will include kinetic modeling of the factors for quantitative and automatic assessment of the kidney function.

CONCLUSION: Factor analysis method can be used for automatic quantitative estimation of renal perfusion from dynamic contract enhanced MR images and to differentiate physiologically different regions in dynamic MRU.

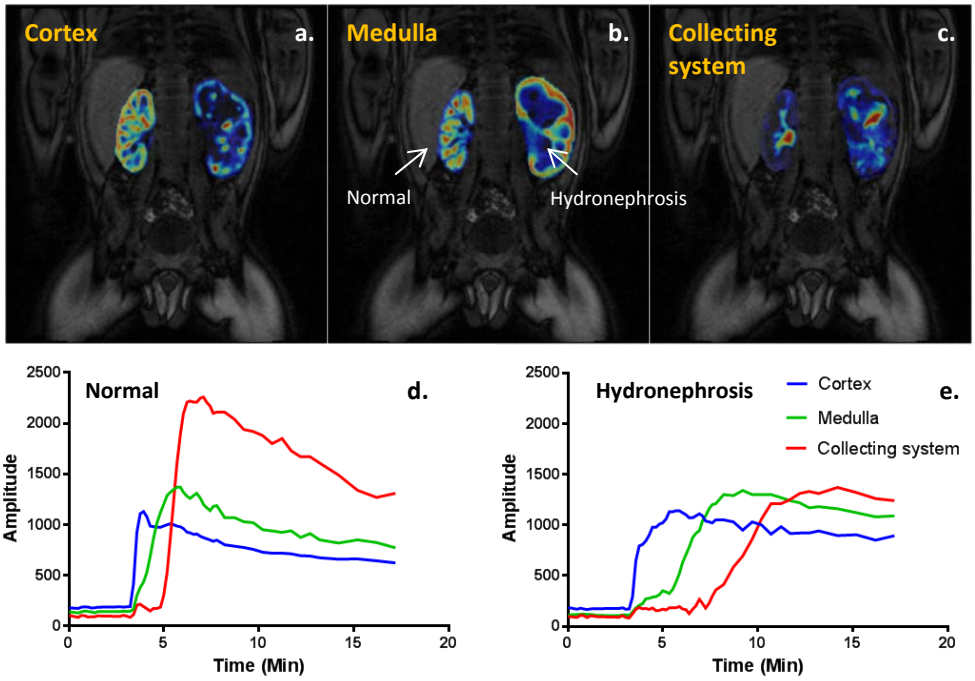

Figure. Factor analysis method separated three physiologically different regions in kidney: Cortex (a.), Medulla (b.) and Collecting system (c.). Dynamic curve of obstructed kidney (e.) demonstrate delayed time-to-peak intensity on both cortical (blue), medullary (green) and excretory (red) phases compared to normal kidney (d.).

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