THE RELATIONSHIP OF ELASTICITY VALUES WITH RENAL FUNCTION TESTS IN PEDIATRIC RENAL TRANSPLANTS

Evrim OZMEN, Duygu CENGIZ, Evren UZER, Ozlem UNLUGEDIK, Ilmay BILGE

Koc University School of Medicine, Department of Radiology

- No conflicts of interest to declare

BACKGROUND

- Elastography and liver fibrosis
  - Adult and pediatric population [1,2]
- Kidney elasticity and fibrosis
  - Adult population[3-6]
  - Pediatric population
    - 95 children
    - 31 kidney transplants[7]

BACKGROUND

- Early detection of renal transplant dysfunction
  - Chronic renal failure
- Routine transplant biopsy to detect rejection
- Biopsy
  - Invasive test
  - Complications

PURPOSE

To investigate relationship between

Renal function test

Elasticity of the kidney transplants

In pediatric population

To find a new parameter

- For detection of transplant disfunction in the early period
- Decrease unnecessary biopsies

PATIENTS AND METHODS

- Ethic committee & written consent
- Prospective study
- One operator with fifteen years of experience
- 2D shear wave elastography
  - GE LOGIQ E10
- Renal doppler ultrasonography for transplant kidney from live donor
- February-October 2021
- 12 measurements of different regions (upper, mid, lower)
- Same region of interest size (0.1 cm^2)
- Linear probe (2-9 MHz)
- Supine position

Figure 1: GE LOGIQ E10 with linear probe

PATIENTS AND METHODS

Patients:

21 children

- 12 male (57.1%)
- 9 female (42.9%)
- Mean age = 9.6 years
  - Ranging from 18 months to 17 years)
- One child was excluded from analysis because of technical difficulty.
- All patients had renal transplantation from living donors at least 6 months ago.

	Male	Female
Number of patients	12 (57.1%)	9 (42.9%)
Mean age	8.96 years	10.5 years

Table 1: Study population demographic characteristics

PATIENTS AND METHODS

Laboratory values

- Creatinine
- Cystatin C (except one patient)
- Blood urea nitrogen (BUN)
- Albumin
- Estimated glomerular filtration rate
  - Calculated with Schwartz formula
- Within one week

PATIENTS AND METHODS

Statistical analysis

- SPSS (v23.0; Chicago, IL)
- Spearman correlation coefficient
  - Correlatations between

    Mean- median of elasticity values

    Renal function tests
- $p < 0.05$ statistically significant
- Intraclass correlation coefficient
  - Intraobserver reproducibility
  - 12 measurements per kidney transplant

RESULTS

- For 21 out of 22 children, elastography measurements were possible
  - 95.45%
  - Obesity

Intraobserver variability

- Intraclass correlation coeffient = 0.72

Moderate

<0.5 : Poor
0.5-0.75: Moderate
0.75-0.9 : Good
> 0.9 : Excellent

RESULTS

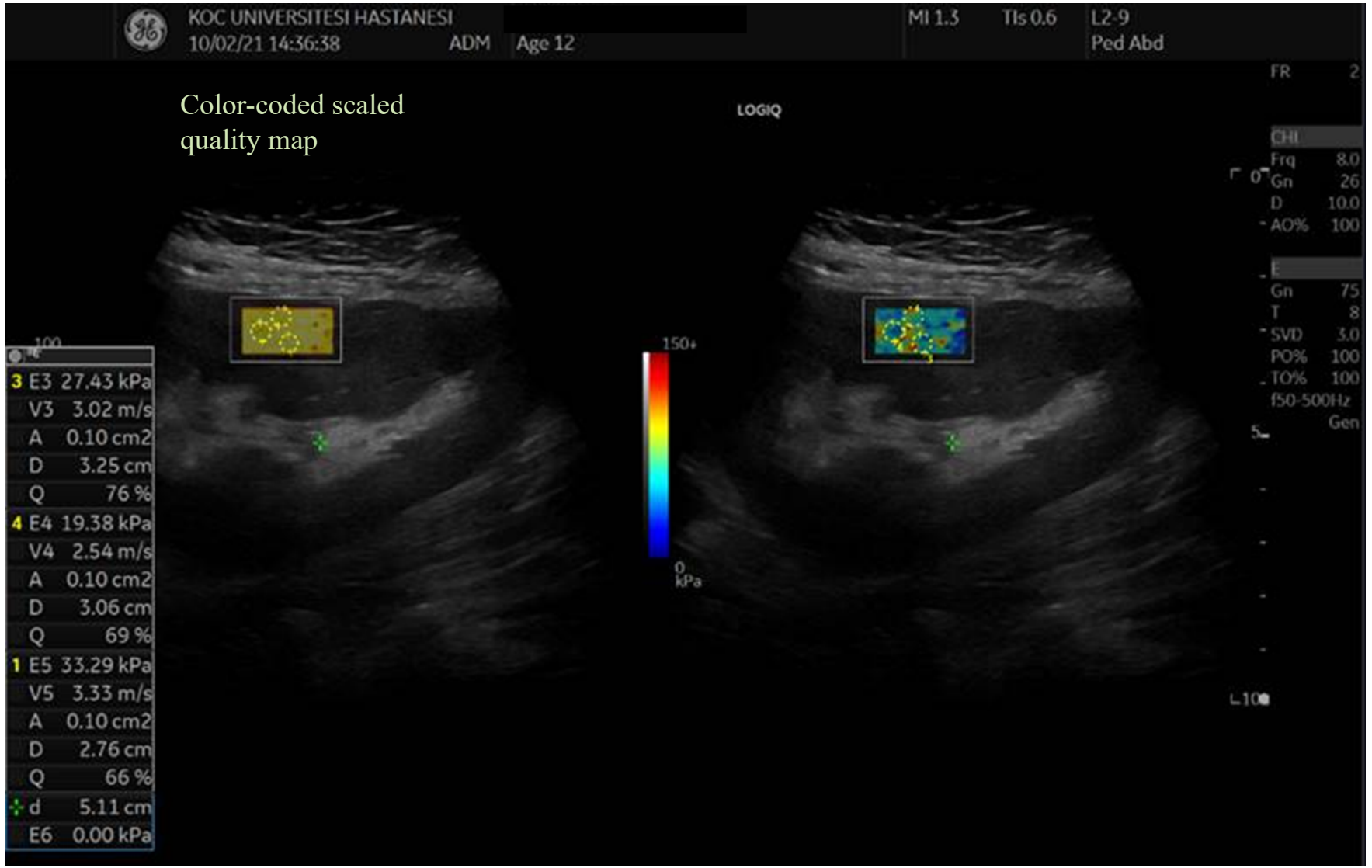
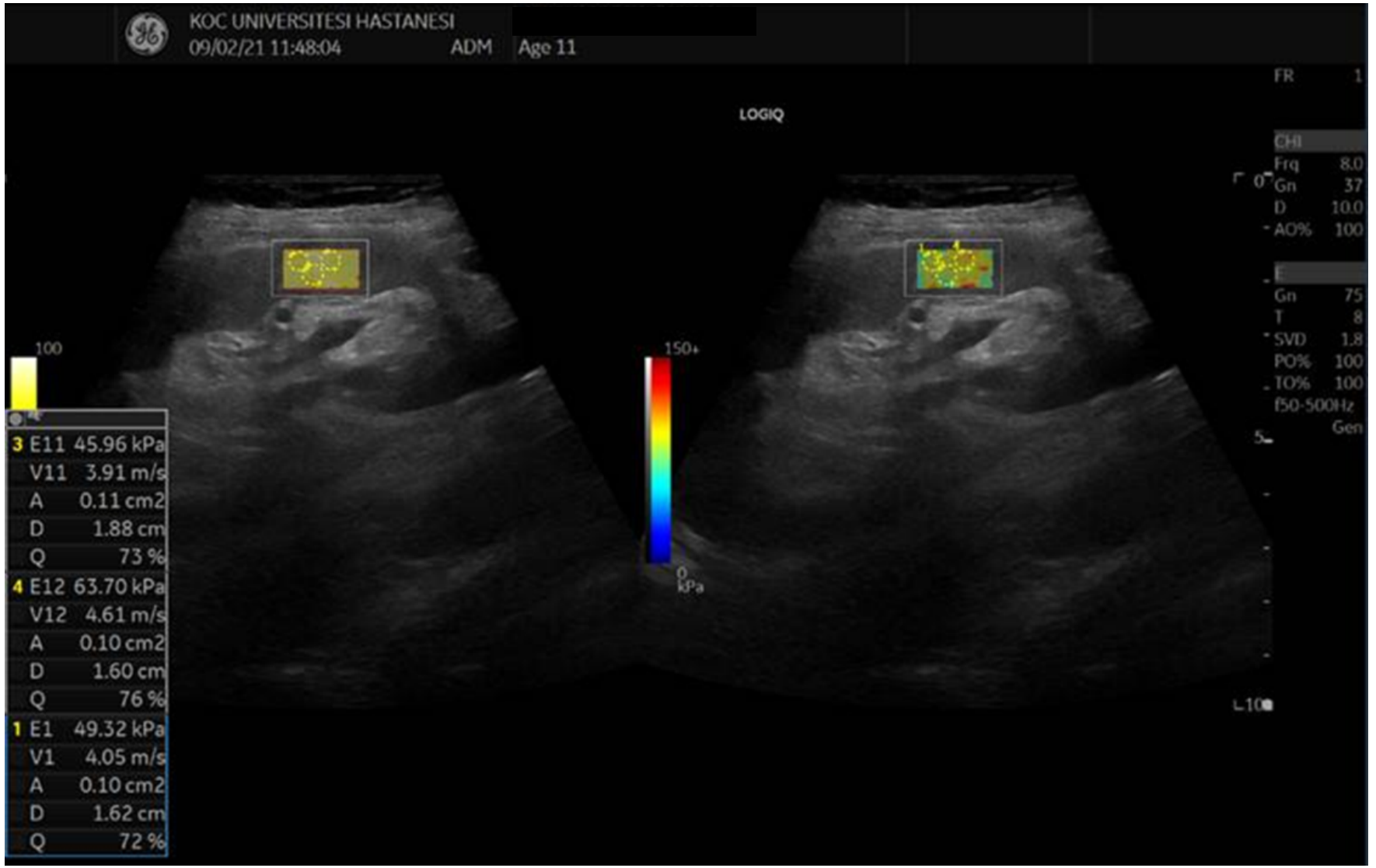


Figure 2: Shear wave elastography measurements of 12 year-old male with renal transplant

RESULTS

Figure 3: Shear wave elastography measurements of 11 year-old male with renal transplant



RESULTS

Mean	E mean values of 21 patients =25.92 kPa
Mean	E median values of 21 patients =25.99 kPa
Mean	E Interquartile range (IQR)/median (%) = 22.65

RESULTS

Number	Gender	Age (years)	E1 (kPa)	E2 (kPa)	E3 (kPa)	E4 (kPa)	E5 (kPa)	E6 (kPa)	E7 (kPa)	E8 (kPa)	E9 (kPa)	E10 (kPa)	E11 (kPa)	E12 (kPa)	E mean (kPa)	E median (kPa)	E IQR	E IQR/median (%)
1	M	9	25.69	29.12	25.72	24.53	22.81	25.23	29.73	22.68	29.11	23.32	20.36	24.63	25.0939	24.93	3.46	13.9
2	F	11	17.26	18.46	17.57	14.63	17.13	12.49	13.48	19.64	19.01	20.14	19.99	17.57	17.09709	17.57	3.45	19.6
3	F	16	17.78	18.86	13.81	13.65	23.62	20.29	19.01	14.96	18.73	16.3	16.44	17.11	17.34188	17.11	4.02	23.5
4	M	2	17.41	17.38	29.5	14.66	29.37	19.41	28.85	29.36	25.61	16.95	24.24	19.37	22.0034	21.82	11.57	53
5	F	10	30.08	50.07	48.24	39.29	54.89	26.89	33.71	24.57	28.93	32.91	33.31	35.34	35.42902	33.31	16.78	50.4
6	F	16	39.64	33.39	26.3	31.92	31.98	29.2	24.3	34.93	40.5	38.87	23.32	20.44	30.54988	31.95	10.12	31.7
7	M	11	49.32	61.55	44.57	43.71	51.45	66.87	55.25	56.66	44.66	54	45.96	63.7	52.61113	52.72	12.25	23.2
8	M	12	16.97	17.04	27.43	19.38	33.29	22.88	13.06	32.89	19.4	24.84	16.09	20.05	21.10705	19.73	8.47	42.9
9	M	9	30.3	25.15	21.32	25.28	21.34	21.4	27.32	20.17	28.93	22.85	28.03	19.16	24.00948	24	6.16	25.7
10	M	13.5	23.8	22.47	18.78	17.96	21.03	32.62	16.63	23.45	28.8	23.45	21.08	16.28	21.7462	21.77	4.97	22.8
11	M	14	26.25	16.76	24.33	24.43	21.78	23.13	25.12	25.68	28.33	24.27	27.15	24.08	24.09008	24.43	2.26	9.3
12	M	13	21.68	17.86	25.44	30.93	28.61	21.3	17.87	19.37	12.15	23.53	15.55	27.07	21.08793	21.3	6.62	31.1
13	F	8	22.84	18.28	15.31	25.45	31.86	18.86	20.08	25.82	23.01	22.14	12.15	12.26	19.89529	21.11	6.08	28.8
14	F	4.5	35.58	32.74	34.22	47.22	38.22	36.18	40.88	43.49	36.67	36.02	34.39	33.97	37.25155	36.1	4.54	12.6
15	F	6	33.67	22.83	16.72	19.65	29.97	25.79	22.26	24.79	23.14	26.91	29.76	25.06	24.63759	24.93	4.94	19.8
16	M	1.5	36.98	24.27	26.78	29.15	31.13	27.73	27.82	25.95	34.71	32.34	37.47	33.33	30.35535	30.14	6.19	20.5
17	F	7.5	35.68	34.3	37.09	38.32	33.98	35.44	37.66	36.78	41.9	37.97	42.38	38.22	37.39467	37.38	2.62	7
18	F	15.5	48.1	23.13	41.05	32.04	32.32	28.51	33.91	40.94	30.16	40.57	45.77	33.61	35.12204	33.76	9.4	27.9
19	M	4	24.03	16.21	34.74	30.63	26.85	23.96	16.8	25.86	26.59	20.28	25.7	20.42	23.78509	24.87	6.28	25.2
20	M	17	17.58	19.61	21.08	18.97	24.76	23.7	21.2	25.08	25.26	22.89	30.26	26.14	22.79402	23.3	4.41	18.9
21	M	1.5	26.32	27.01	23.15	27.71	19.35	18.03	24.8	20.86	24.92	20.45	26.75	25.4	23.50913	24.86	5.67	22.8

Table 2: Shear wave elastography measurements of the patients

RESULTS

No statistically significant correlation between

- Means of the elasticity values and
  - eGFR
  - Cystatin c
  - Blood urea nitrogen
  - Albumin

No statistically significant correlation between

- Medians of the elasticity values and
  - eGFR
  - Cystatin c
  - Blood urea nitrogen
  - Albumin

	E mean (kPa)-eGFR	E median(kPa)-e GFR	E mean (kPa)-Cystatin C	E median (kPa)-Cystatin C	E mean (kPa)-Albumin	E median (kPa)- Albumin	E mean (kPa)-BUN	E median (kPa)- BUN
Coeffient (r)	0.124675	0.132511	0.317293	0.300865	-0.14165	-0.09945	0.293717	0.343975
p value	0.590261	0.566921	0.172837	0.197403	0.540222	0.668006	0.196257	0.126811

Table 3: Spearman correlation coffiecients and p-values

DISCUSSION

- Pediatric kidney transplant with 2D SWE
  - Feasibility study in 2017 in healthy children[9]
  - First pediatric kidney transplant elastography study was published in April 2021[7]

- Technical success rate was higher
  - With linear probe 2-9 MHz in our study 95.45%
  - Point shear wave: 51.1% with linear probe (4-9 MHz)[10]
  - 2D SWE: 50% with linear probe (4-15 MHz) for transplant kidneys[7]
  - Frequencies of linear probes had different ranges in these studies.

DISCUSSION

- Intraobserver correlation of measurements was 0.72.
  - Intraobserver correlations of transplants= 0.85[7]
  - Native kidneys, adult population= 0.77[11]

- **No correlation was found between mean-median elasticity values and renal function tests.**
  - Consistent with the previous study[7]

LIMITATIONS

- Limited case numbers
- Correlation with kidney function tests
- Absence of histopathologic correlation
- No interobserver correlation

CONCLUSION

Transplant kidney elastography is feasible to conduct in pediatric population

It needs time to become a valuable non-invasive test in early detection of transplant disfunction.

REFERENCES

1- Barr RG, Ferraioli G, Palmeri ML, Goodman ZD, Garcia-Tsao G, Rubin J, Garra B, Myers RP, Wilson SR, Rubens D, Levine D. Elastography Assessment of Liver Fibrosis: Society of Radiologists in Ultrasound Consensus Conference Statement. Radiology. 2015 Sep;276(3):845-61. Epub 2015 Jun 16. PMID: 26079489.

2-Franchi-Abella S, Corno L, Gonzales E, Antoni G, Fabre M, Ducot B, Pariente D, Gennisson JL, Tanter M, Corréas JM. Feasibility and Diagnostic Accuracy of Supersonic Shear-Wave Elastography for the Assessment of Liver Stiffness and Liver Fibrosis in Children: A Pilot Study of 96 Patients. Radiology. 2016 Feb;278(2):554-62. Epub 2015 Aug 21. PMID: 26305193.

3- Chhajer G, Arunachalam VK, Ramasamy R, Mehta P, Cherian M. Elastography: a surrogate marker of renal allograft fibrosis - quantification by shear-wave technique. Pol J Radiol. 2021 Mar 7;86:e151-e156. doi: 10.5114/pjr.2021.104582. PMID: 33828625; PMCID: PMC8018265.

4- Wang Z, Yang H, Suo C, Wei J, Tan R, Gu M. Application of Ultrasound Elastography for Chronic Allograft Dysfunction in Kidney Transplantation. J Ultrasound Med. 2017 Sep;36(9):1759-1769. doi: 10.1002/jum.14221. Epub 2017 May 15. PMID: 28503746.

5- Sommerer C, Scharf M, Seitz C, Millonig G, Seitz HK, Zeier M, Mueller S. Assessment of renal allograft fibrosis by transient elastography. Transpl Int. 2013 May;26(5):545-51. doi: 10.1111/tri.12073. Epub 2013 Feb 6. PMID: 23383606.

6- Ma MK, Law HK, Tse KS, Chan KW, Chan GC, Yap DY, Mok MM, Kwan LP, Tang SC, Choy BY, Chan TM. Non-invasive assessment of kidney allograft fibrosis with shear wave elastography: A radiological-pathological correlation analysis. Int J Urol. 2018 May;25(5):450-455. doi: 10.1111/iju.13536. Epub 2018 Feb 14. PMID: 29444550.

REFERENCES

7-Desvignes C, Dabadie A, Aschero A, Ruocco A, Garaix F, Daniel L, et al. Technical feasibility and correlations between shear-wave elastography and histology in kidney fibrosis in children. Pediatr Radiol. 2021 Sep;51(10):1879-1888.

8- Barr RG, Ferraioli G, Palmeri ML, Goodman ZD, Garcia-Tsao G, Rubin J, Garra B, Myers RP, Wilson SR, Rubens D, Levine D. Elastography Assessment of Liver Fibrosis: Society of Radiologists in Ultrasound Consensus Conference Statement. Radiology. 2015 Sep;276(3):845-61. doi: 10.1148/radiol.2015150619. Epub 2015 Jun 16. PMID: 26079489.

9-Grass L, Szekely N, Alrajab A, Bui-Ta TTT, Hoffmann GF, Wühl E, et al. Point shear wave elastography (pSWE) using Acoustic Radiation Force Impulse (ARFI) imaging: a feasibility study and norm values for renal parenchymal stiffness in healthy children and adolescents. Med Ultrason. 2017 Nov 29;19(4):366-373.

10- Grass L, Szekely N, Alrajab A, Bui-Ta TTT, Hoffmann GF, Wühl E, et al. Point shear wave elastography (pSWE) using Acoustic Radiation Force Impulse (ARFI) imaging: a feasibility study and norm values for renal parenchymal stiffness in healthy children and adolescents. Med Ultrason. 2017 Nov 29;19(4):366-373.

11- Hwang J, Kim HW, Kim PH, Suh CH, Yoon HM. Technical Performance of Acoustic Radiation Force Impulse Imaging for Measuring Renal Parenchymal Stiffness: A Systematic Review and Meta-Analysis. J Ultrasound Med. 2021 Dec;40(12):2639-2653. doi: 10.1002/jum.15654. Epub 2021 Feb 18. PMID: 33599306.

THANK YOU