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A new machine technique in cord: Elastosonography

Kord için yeni bir makine tekniği: Elastosonografi

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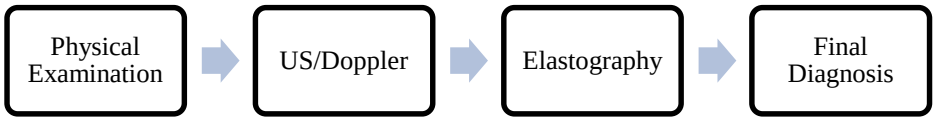
Önemli noktalar (Highlights)

- *Elastosonografi tekniği, kord torsiyonu tanısında diğer prosedürlerle birlikte yer alabilir/Elastosonography technique may have a part with other procedures in diagnosis of cord torsion.*
- *Elastosonografi software kullanıldı/Elastosonography software was used.*
- *Çalışma elastosonografi tekniğini tanıya entegre ediyor/The study integrates elastosonography technique in diagnosis.*

Grafik Özet (Graphical Abstract)

The elastosonography strategy may have a part with other indicative procedures in diagnosis of cord torsion.



Amaç (Aim)

Deneysel araştırmanın amacı, kord torsiyonunun belirlenmesi ve müdahalesinde bir hedef strateji olarak sertliği araştıran elastosonografinin uygulanabilirliğini belirlemektir. / The point of experimental research is to determine the viability of elastosonography, which investigates stiffness as a target strategy in determination and intervention of spermatic cord torsion.

Tasarım ve Yöntem (Design & Methodology)

Benzer ağırlık ve yaştaki 16 erkek tavşan, 8 adet olmak üzere 2 gruba ayrıldı. Grup 1'de kord sabitti; Grup 2'de ise aynı kord torsiyon edildi. 1-2 saatlik iskemik periyoddan sonra B mod US ve lineer prob ile elastosonografi prosedürleri uygulandı. / 16 male rabbits of a similar weight and age were separated into 2 groups including 8 rabbits. In Group 1, cord was constant; in Group 2, the same cord was torsioned. After 1-2 hours of ischemic period B mode US and elastosonography procedures were applied with a linear probe.

Özgünlük (Originality)

Kord torsiyonu tanısında elastosonografi tekniği diğer prosedürlerle birlikte araştırılmış olup, software uygulanması ile teknik tanıya entegre ediliyor. / In the diagnosis of cord torsion, elastsonography technique has been investigated together with other procedures, and the technique is integrated into the diagnosis with software application.

Bulgular (Findings)

1-2-24 saatte torsiyone kordda elastosonografi tahminlerinde istatistiksel olarak artış tespit edildi. Elastosonografi değerleri 24 saatte komşu kordda anlamlıydı. / Statistically increment was recognized in elastosonography estimations in torsioned cord at 1-2-24 hours. Elastosonography values were significant in adjacent cord at 24 hours.

Sonuç (Conclusion)

Kord torsiyonu tanısında elastosonografi stratejisinin diğer gösterge prosedürlerle birlikte yeri olabilir. / Elastosonography strategy may have a part with other indicative procedures in diagnosis of cord torsion.

Etik Standartların Beyanı (*Declaration of Ethical Standards*)

Bu çalışma Giresun Üniversitesi Hayvan Deneyleri Yerel Etik Kurulu (2014/6) tarafından onaylanmıştır. / This study was approved by the Giresun University Animal Experiments Local Ethics Committee (2014/6).

Kord için yeni bir makine tekniği: Elastosonografi

(Bu çalışma International Congress on Biological and Health Sciences 2021 konferansında sunulmuştur. / This study was presented at International Congress on Biological and Health Sciences 2021 conference.)

Araştırma Makalesi / Research Article

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ÖZ

Elastosonografi görüntüleme teknolojisi cihazlarına yeni eklenen bir teknolojidir. Elastosonografi ile özellikle ortam sertliği bulguların farklı şekilde değerlendirilmesi mümkündür. Bu özelliklere sahip cihazlar hem teknolojik olarak yeni hem de yüksek çözünürlüğe sahip oldukları için daha detaylı bilgiler veren cihazlardır. Pediatri grubunda kord torsiyonu en önemli olaylar arasındadır. Diğer akut olaylardan ayırt edilmesi tanı ve tedavide kafa karıştırıcıdır. Klasik siyah-beyaz görüntüler, renkli Doppler görüntüleri ve elastosonografi değerlendirmesinin hep birlikte yapılmasıyla çok başarılı sonuçlar vermektedir. Deneysel araştırmanın amacı, kord torsiyonunun belirlenmesi ve müdahalesinde bir hedef strateji olarak sertliği araştıran elastosonografinin uygulanabilirliğini belirlemektir. Benzer ağırlık ve yaştaki 16 erkek tavşan seçildi. 8 tavşan olmak üzere 2 gruba ayrıldı. Grup 1'de sağ testis sabitti; Grup 2'de ise aynı testis saat yönünde 720° döndürüldü ve stabilize edildi. 1-2 saatlik iskemik dönemden sonra elastosonografi tekniği uygulandı. Bununla birlikte, olası ilerlemeleri fark etmek için sol kord 24 saatte tekrar değerlendirildi; çünkü iskemi sol kordu da etkileyebilir. B modu US ve elastosonografi prosedürleri lineer prob ile uygulandı. 1-2-24 saatte sağ kordun elastosonografi değerlerinde istatistiksel olarak artış tespit edildi ($p<0.05$). 1-2 saatte sol kord grupları arasında önemli bir değişiklik olmadı. Elastosonografi değerleri 24 saatte sol kordta anlamlıydı ($p<0.05$). Kord torsiyonunun elastosonografi değerleri, iskeminin genişlemesiyle birlikte açıkça ortaya çıktı. Kord torsiyonu tanısında elastosonografi stratejisinin diğer belirteç prosedürlerle birlikte rol oynayabileceği görüldü.

Anahtar Kelimeler: Kord, elastosonografi, makine tekniği.

A new machine technique in cord: Elastosonography

ABSTRACT

B mode US imaging with elastosonography tecnology was performed on the cords by 4-13 MHz linear probe (Esaote, MyLab60 with Elaxto application). The elastosonography technic demonstrated a colour map over B mode image. Different colours extended from green (soft) to ruddy (hard) to illustrate tissue feature after compression-decompression periods. In kids, spermatic cord with testicular torsion is among the main significant events. Differentiation from other acute scrotal events is confusing in diagnosis and therapy. The point of experimental research is to determine the viability of elastosonography, which investigates stiffness as a target strategy in determination and intervention of spermatic cord torsion. 16 male rabbits of a similar weight and age were chosen. They were separated into 2 groups including 8 rabbits. In Group 1, right testis was constant; in Group 2, the same testis experienced 720° curve a clockwise way and stabilized. After 1-2 hours of ischemic period, elastosonography estimations were applied. Nonetheless, the left spermatic cord was estimated again at 24 hours to notice the possible progressions; because ischemia may also have an effect to the left spermatic cord. B mode US and elastosonography procedures were applied with a linear probe. Statistically increment was recognized in elastosonography estimations of right spermatic cord at 1-2-24 hours ($p<0.05$). There were no significant changes between the groups of left spermatic cord at 1-2 hours. Elastosonography values were significant in left spermatic cord at 24 hours ($p<0.05$). The elastosonography estimations of the spermatic cord torsion appeared evidently with the expansion in span of ischemia. It was seen that the elastosonography strategy may have a part with other indicative procedures in diagnosis of cord torsion

Keywords: Cord, elastosonography, machine technique.

1. INTRODUCTION

Elastosonography is indeed a well promising noninvasive ultrasound based diagnostic modality that could probably be valuable in early diagnosis. Perhaps the most significant urologic crises are spermatic cord and testis torsion in kids. Irritation, injury, and extreme work out may start the progress between ages of 10-20, however it is mostly seen in adolescence and neonatal period; and could also be occur idiopathically. The rotation occurs where the sperm ducts are located and leads to blockage in blood flow. Torsion risk is more prominent in youngsters with undescended or retractile testis; likewise, normal location also has risk. Testicles may be removed or inefficiency may occur on delay if the torsion is not detected and treated in first hours. The disease affects one testis; although, wounds or tissue defects may also seen in the other side due to ischemia/reperfusion [1,2]. Ultrasonography (USG) with Doppler imaging tool is the primary diagnostic tool. [1-

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,3]. Conclusion and careful fix inside the main hour are indispensable to recover the organ. The first main hours for intervention are essential to the recovery of the organ. Patients with torsion have a significant spot in clinical delayed misbehaviour claims [1-3]. It is essential to differentiate infection (orchitis/epididymitis) which exist with serious scrotal agony similar like torsion. Patients are suffering from serious progressive agony due to side effect of spermatic cord torsion. Absence of pyrogenic temperature in the region is significant to differentiate from epididymorchitis. Gray scale USG has an advantage to demonstrate the corruption of the parenchyma, though Doppler imaging significant to show nonappearance of blood passage [3, 4]. Elastosonography has been utilized in determination of necrotic tissues in these days [5, 6]; this technique shows objectively the estimated tissue firmness by dark scale or color coded images [7-9]. This real time imaging technique is applied particularly in this reason. This is the prominent noninvasive assessment of tissue harm particularly in liver parenchyma disorders [9]. Elevated elastosonography ratios are related to tissue stiffness composed by ischemia. Thus, we observed high elastosonography ratios are related with tissue ischemia in spermatic cords by torsion. In our examination, we emphasize for the effect of real time tissue elastosonography technique to determine spermatic cord torsion.

2. MATERIAL and METHOD

The research was approved by local ethical committee (2014/06); we had investigate 16 similar weight and age white male New Zealand rabbits in veterinary research laboratory of Giresun University. 16 rabbits were separated in two groups of 8. In Group 1 (Sham), the gonad was settled and assessed by a radiologist with elastosonography. In Group 2 (Torsion), the right gonad was torsioned 720 degree clockwise, settled to diagram models of twist with 1-2-24 hours of ischemia and toward the finish of the first, second and 24th hours and assessed by elastosonography. Synchronous estimations were held on the evacuated spermatic cords, yet the left spermatic cord was re-evaluated at 24 hours to demonstrate the progressions.

Surgical assessment

All rabbits were cleaned at mid-region and shaved before the methodology. We employed intramuscular 0.2mg/ml Fentanyl+10mg/ml fluanisone+0.3ml diazepam, afterwards the animals were fixed on backs, a midsection was held through a sterile middle cut below umbilical zone. Testis tissues were sutured by 5/0polyglactine materials. 0.1ml/kg Hypnorm was utilized by *im* at 30th-minute periods for sedation. In Group 2, right testis was 720° clockwise torsioned and settled as characterized by Aslan et al [1].

Radiologic analysis

B mode US imaging with elastosonography method was performed on the spermatic cords by 4-13 MHz linear probe (Esaote, MyLab60 with Elaxto application). The elastosonography methodology demonstrated a colour map over B mode image. Different colours extended from green (soft) to ruddy (hard) to illustrate tissue feature after compression-decompression periods. Region of interest where measurements took place was the spermatic cord above the entrance of the testicle that it thickens the most by torsion. We compared concern regions with fatty tissue. The pressure proportions have been mechanically resulted via way of means of the computer program. Strain proportion method analyzes the stiffness of the main lesion with regards to encompassing tissues. The assessment of strain degree is based on favoured subjective elastosonography values. Two selected regions (A: tortoise tissue; B: reference soft tissue) were chosen on for quantitative evaluation. The strain value was obtained automatically by B/A proportion. The higher ratio is due to hardness.

Statistical analysis

The data acquired in our investigation was assessed by SPSS 20.0 bundle program. The frequencies and percentiles of the information are appeared. Mann–Whitney U test was utilized for factors to gather of two that were not scatter regularly while looking at contrasts between the 2 gatherings. Wilcoxon Sign test was utilized for assessment of contrasts between the estimation seasons of factors acquired at various occasions. The p value under 0.05 was considered as measurably critical.

3. RESULTS

The elastosonography values in right spermatic cord at first, second and 24th hours were recorded. There was a measurably huge distinction between the gatherings regarding elastosonography values in the privilege spermatic cord at first, second and 24th hour assessments ($p<0.05$) (Figure 1). In particular, the privilege spermatic cord esteems at 1-2-24th hours were observed to be altogether increased than those in 0th hour ($p<0.05$). There was huge distinction between the privilege spermatic cord esteems at 1-2-24th hours ($p<0.05$). Besides, the privilege spermatic cord esteems at the 24th hour were observed to be essentially increased than those at the second hour ($p<0.05$). The elastosonography values in left spermatic cord at first, second and 24^{th} hours were recorded. There was no huge contrast between the gatherings as far as elastosonography ratios in left spermatic cord ($p>0.05$) at 1-2 hours; afterwards, measurably critical increment was identified in elastosonography esteem in left spermatic cord at 24th hour ($p<0.05$) (Fig. 2). When elastosonography assessments of left spermatic cord at various occasions of ischemia were assessed, we found that there was no critical distinction between the estimations in the 0^{th} and first, 0^{th} and second, and 1-2 hours ($p>0.05$). Nonetheless, the qualities in the 24^{th} hour apparently was essentially more remarkable than those in 0-1-2 hours ($p<0.05$) (Table 3).

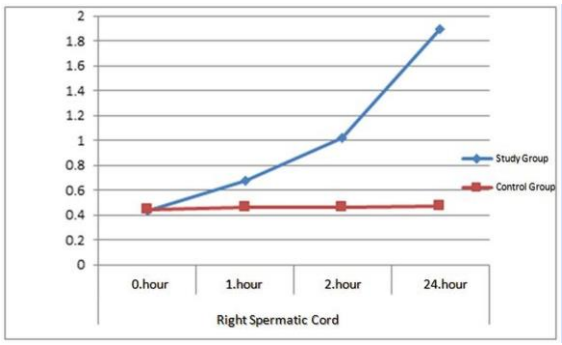

Figure 1. Mean Elastography values of the right spermatic cord over time (* p < 0.05)

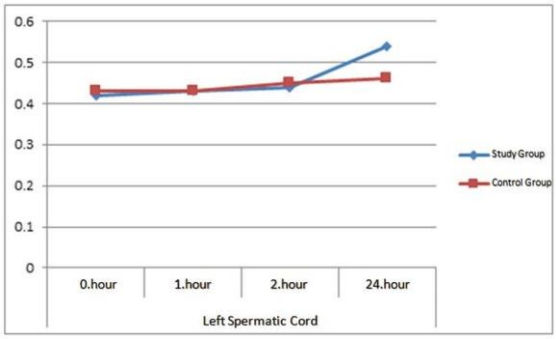

Figure 2. Mean Elastography values of the left spermatic cord over time (* p < 0.05)

Table 1. The comparison of elastography values of right spermatic cord evaluations between control and study groups (The Mann–Whitney U Test, *p<0.05)

								Mann Whitney U Test	
		Number	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**Rank**	**z**	**p**
Right Spermatic Cord (0.hour)	**Study Group**	8	0,43	0,43	0,36	0,52	0,05	8	9,487	0,721
	Control Group	8	0,44	0,44	0,38	0,55	0,06	9		
	Total	16	0,44	0,44	0,36	0,55	0,05			
Right Spermatic Cord (1.hour)	**Study Group**	8	0,68	0,69	0,59	0,76	0,06	12,5	-3,363	**0,001**
	Control Group	8	0,46	0,45	0,39	0,57	0,07	4,5		
	Total	16	0,57	0,58	0,39	0,76	0,13			
Right Spermatic Cord (2.hour)	**Study Group**	8	1,02	1,00	0,91	1,21	0,11	12,5	-3,366	**0,001**
	Control Group	8	0,46	0,46	0,39	0,54	0,06	4,5		
	Total	16	0,74	0,73	0,39	1,21	0,30			
Right Spermatic Cord (24.hour)	**Study Group**	8	1,89	1,91	1,63	2,24	0,19	12,5	-0,363	**0,001**
	Control Group	8	0,47	0,45	0,40	0,55	0,06	4,5		
	Total	16	1,18	1,09	0,40	2,24	0,75			

Table 2. The comparison of right spermatic cord values at different hours of ischemia in the study group (The Wilcoxon Sign Test, $^{*}p$<0.05).

	Right Spermatik Cord						**Wilcoxon Sign Test**	
	Number	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**z**	**p**
(0.hour)	8	0,43	0,43	0,36	0,52	0,05	-2,521	**0,012**
(1.hour)	8	0,68	0,69	0,59	0,76	0,06		
(0.hour)	8	0,43	0,43	0,36	0,52	0,05	-2,521	**0,012**
(2.hour)	8	1,02	1,00	0,91	1,21	0,11		
(0.hour)	8	0,43	0,43	0,36	0,52	0,05	-2,521	**0,012**
(24.hour)	8	1,89	1,91	1,63	2,24	0,19		
(1.hour)	8	0,68	0,69	0,59	0,76	0,06	-2,533	**0,011**
(2.hour)	8	1,02	1,00	0,91	1,21	0,11		
(1.hour)	8	0,68	0,69	0,59	0,76	0,06	-2,521	**0,012**
(24.hour)	8	1,89	1,91	1,63	2,24	0,19		
(2.hour)	8	1,02	1,00	0,91	1,21	0,11	-2,521	**0,012**
(24.hour)	8	1,89	1,91	1,63	2,24	0,19		

The elastosonography values in left spermatic cord at first, second and 24th hours were recorded. There was no huge contrast between the gatherings as far as elastosonography ratios in left spermatic cord ($p>0.05$) at 1-2 hours; afterwards, measurably critical increment was identified in elastosonography esteem in left spermatic cord at 24th hour ($p<0.05$) (Fig. 2). When elastosonography assessments of left spermatic cord at various occasions of ischemia were assessed, we found that there was no critical distinction between the estimations in the 0th and first, 0th and second, and 1-2 hours ($p>0.05$). Nonetheless, the qualities in the 24th hour apparently was essentially more remarkable than those in 0-1-2 hours ($p<0.05$) (Table 3).

Table 3. The comparison of elastography values of left spermatical evaluations between control and study groups (The Mann–Whitney U Test, $^{*}p<0.05$)

								Mann Whitney U Test	
		Number	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**Rank**	**z**	**p**
Left Spermatic Cord (0.hour)	**Study Group**	8	0,42	0,41	0,36	0,53	0,06	7,88	0,528	0,645
	Control Group	8	0,43	0,44	0,35	0,52	0,05	9,12		
	Total	16	0,43	0,42	0,35	0,53	0,05			
Left Spermatic Cord (1.hour)	**Study Group**	8	0,43	0,41	0,36	0,53	0,06	7,94	0,475	0,645
	Control Group	8	0,43	0,45	0,36	0,50	0,05	9,06		
	Total	16	0,43	0,43	0,36	0,53	0,05			
Left Spermatic Cord (2.hour)	**Study Group**	8	0,44	0,42	0,38	0,57	0,07	7,69	0,689	0,505
	Control Group	8	0,45	0,45	0,35	0,52	0,06	9,31		
	Total	16	0,44	0,44	0,35	0,57	0,06			
Left Spermatic Cord (24.hour)	**Study Group**	8	0,54	0,55	0,38	0,68	0,10	10,56	-1,735	0,083
	Control Group	8	0,46	0,45	0,37	0,55	0,07	6,44		
	Total	16	0,50	0,49	0,37	0,68	0,09			

Table 4. The comparison of left spermatic cord values at different hours of ischemia in the study group (The Wilcoxon Sign Test, $^{*}p<0.05$).

	Left Spermatic Cord						**Wilcoxon Sign Test**	
	Number	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**z**	**p**
(0.hour)	8	0,42	0,41	0,36	0,53	0,06	-0,962	0,336
(1.hour)	8	0,43	0,41	0,36	0,53	0,06		
(0.hour)	8	0,42	0,41	0,36	0,53	0,06	-1,628	0,103
(2.hour)	8	0,44	0,42	0,38	0,57	0,07		
(0.hour)	8	0,42	0,41	0,36	0,53	0,06	-2,524	**0,012**
(24.hour)	8	0,54	0,55	0,38	0,68	0,10		
(1.hour)	8	0,43	0,41	0,36	0,53	0,06	-1,552	0,121
(2.hour)	8	0,44	0,42	0,38	0,57	0,07		
(1.hour)	8	0,43	0,41	0,36	0,53	0,06	-2,371	**0,018**
(24.hour)	8	0,54	0,55	0,38	0,68	0,10		
(2.hour)	8	0,44	0,42	0,38	0,57	0,07	-2,371	**0,018**
(24.hour)	8	0,54	0,55	0,38	0,68	0,10		

4. DISCUSSION

Spermatic cord twist is perhaps the most widely recognized distress in adolescence. It was characterized as a poor situation firstly in 1776; and afterwards in 1840, Delasiavue announced an adolescent who achieved torsion because of undescended gonad [9,10]. The assessment of spermatic cord twist, which is among the serious scrotal distress, is significant. Rapid diagnosis leads significant outcomes in youngsters; the age is vital. The pediatric ages, particularly the neonatal and prepubertal periods, conveys increased risk of spermatic cord twist. The symptoms start with unexpected extreme agony. [10,11]. The pediatric patients often describe these symptoms as stomach or groin pain; these symptoms should be carefully evaluated in youngsters. Absence of fever and nausea and regurgitation are the spermatic cord twist symptoms [11,12].

The diagnosis of significant spermatic cord twisting is relatively easy with the present innovations; gray scale US and elastosonography with Doppler imaging tools are both in these strategies. Elastosonography could be a practical imaging strategy that can be utilized to characterize the stiffness of tissue. Elastosonography analyzes the target organ by applying mild tension with the USG probe. Different strategies exist inside the elastosonography techniques include vibroacoustography, transient elastosonography, acoustic radiation, shear wave imaging, and supersonic versatility imaging (13,-15). This is an advantage of differentiation among normal and abnormal tissue. The technique is simple, inexpensive, radiation-free, secure, and promptly repeatable. In Ramnarine et al. examination, elastosonography was demonstrated able to analyze carotid artery plaque [15,16]. In examinations held by Lin et al. on 70 male rodents, and Shi et al. on 62 rabbits, elastosonography was demonstrated as a successful technique in hepatic fibrosis [17, 18]. This examination is potent of the previously mentioned considers. The elastosonography ratios were decided to be essentially increased in torsioned right spermatic cord ($p<0.05$). In their test data on 28 rabbits, Chen et al determined contralateral spermatic cord blood flow altered in USG at 6 and 24 hours after right testicular twist [19]. We observed elastosonography estimates increased in torsioned spermatic cords as the ischemia interval increases. We recommend that elastosonography is a helpful imaging tool aide to USG of spermatic cord twist. A few investigations observe contralateral testiscular injury after testicular twist. Cvetkovic et al. assessed the cytological and laboratory alterations in contralateral gonad after twist in a trial on 28 grown-up male Wistar rodents, and the authors identified the alterations in glutathione(GSH), catalase(CAT), Malondialdehyde(MDA), and thiobarbituric corrosive receptive substances(TBARS) levels in tissue [20]. Our elastosonographic estimations confirms the previous studies and shows elastosonography results may increase at contralateral side.

There was no huge distinction between first and second hour elastosonography values in left spermatic line; however, a critical discrepancy is found in 24th hour. Our results propose contralateral spermatic cord stiffness may be identified at late time of spermatic cord twist; recognized with elastosonography during USG assessment. Goddi et al. investigated the part of elastosonography in separation among malign and benign testis masses and observed elastosonography could differentiate the pathologies from testicular injuries; anyway elastosonography is a valuable tool in diagnosis of small testis masses/pseudo-masses [20,21]. In Gao et al. examination on 20 kidney transfer patients, determined elastosonography is helpful in measuring progress of fibrosis in renal cortex of transfered allografts [21,22]. In Gao et al. in vivo exploratory study, severe renal vein obstruction were formed and a huge distinction were identified in cortex thickness, whereas verified significant difference in tissue stiffness and relaxation time as the duration of renal vein obstruction expanded [20,-23].

Our study reveals the elastosonography values increases by the duration of ischemia. This method might help Doppler study in assessing the obstruction of blood flow within the testis vessels due to spermatic cord twist. We found elastosonography values are increasing after one hour ischemia period. However, we did not assess the benefits in different pathologies of acute scrotum; we propose elastosonography can be utilized as a diagnostic tool in the early stages of spermatic cord twist. Further researches are required to evaluate the performance of elastosonography in other acute scrotal pathologies like epididimitis/orchitis.

5. CONCLUSION

Elastosonography could be a reliable, predominant technique to determine the tissue stiffness of unilateral and controlateral spermatic cord structures by the opportunity of coexistence with B mode USG and Doppler studies in pediatric torsion patients. Elastosonography imaging strategy may contribute with the other analytic procedures in the diagnosis of spermatic cord torsion.

DECLARATION OF ETHICAL STANDARDS

This study was approved by the Giresun University Animal Experiments Local Ethics Committee (2014/6).

AUTHORS' CONTRIBUTIONS

Kadir Öymen HANÇERLİOĞULLARI: Conducted the study, performed experiments, collected the data, analyzed the results, wrote the manuscript.

Alptekin TOSUN: Conducted the study, performed experiments, wrote the manuscript.

CONFLICT of INTEREST

There is no conflict of interest in this study.

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