

## Evaluation of Resistive Index Parameter in Peritoneal Dialysis in Dogs with Experimental Bilateral Proximal Ureteral Obstruction<sup>a, b</sup>

Ali Haydar KIRMIZIGÜL\* Mahir KAYA\*\* Ali BUMİN\*\*\* Aslan KALINBACAK\*\*\*\*

**a** Animal material used in this study was derived from the doctoral thesis of first author "Peritoneal Dialysis Applications in Experimentally Induced Bilateral Ureteral Obstruction in Dogs"

**b** This study was approved by the Ethical Committee of Faculty of Veterinary Medicine, University Ankara, Protocol no: 2002/35.

\* University of Kafkas, Faculty of Veterinary Medicine, Department of Internal Medicine, Kars - TURKEY

\*\* University of Atatürk, Faculty of Veterinary Medicine, Department of Surgery, Erzurum - TURKEY

\*\*\* University of Ankara, Faculty of Veterinary Medicine, Department of Surgery, Ankara - TURKEY

\*\*\*\* University of Ankara, Faculty of Veterinary Medicine, Department of Internal Medicine, Ankara -TURKEY

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### Summary

In this study, resistive index (RI) value that reflects pathologic and physiologic changes in kidneys was investigated after experimental bilateral proximal ureteral obstruction in dogs by Color Doppler Ultrasonography (CDUS).

Six mongrel dogs (3 females and 3 males) were used. Bilateral proximal ureteral obstruction was formed interventionally by laparotomy. Peritoneal dialysis was performed for the clearance of metabolites increased in the blood. Kidneys were examined by CDUS and Gray Scala Ultrasonography (GSU) before and after laparotomy, during the peritoneal dialysis, and the 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> days after removal of the clips from the ureters. RDUS revealed that RI values were not increased during the peritoneal dialysis.

In conclusion, combination of GSU and CDUS is helpful in evaluation of renal diseases, and increased RI value in obstructive renal diseases can be obviated by peritoneal dialysis.

**Keywords:** Dog, Kidney, Resistive index, Ureteral obstruction

### Deneysel Bilateral Proksimal Üreteral Obstrüksiyon Oluşturulan Köpeklerde Peritoneal Diyaliz Uygulamasında Rezistiv İndeks Parametresinin Değerlendirilmesi

### Özet

Bu çalışmada, bilateral proksimal üreteral obstrüksiyon oluşturulan köpeklerde, Renkli Doppler Ultrasonografi (RDUS) ile böbreklerdeki patolojik değişiklikler ve fizyolojik parametrelerin bir göstergesi olan Rezistiv İndeks (Rİ) değerindeki değişikliklerin belirlenmesi amaçlandı.

Çalışmada 3 dişi, 3 erkek olmak üzere toplam 6 melez köpek kullanıldı. Hayvanlarda, genel anestezi altında deneysel laparotomi yapılarak, bilateral proksimal üreteral obstrüksiyon oluşturuldu. Kanda artan metabolitlerin uzaklaştırılması için peritoneal diyaliz uygulandı. Obstrüksiyon oluşturulmadan önce ve sonra, peritoneal diyaliz sırasında ve üreterlerdeki klipsler çıkarıldıktan sonra 5, 10 ve 15. günlerde böbreklerin RDUS ve Gri Skala Ultrasonografi (GSU) ile muayeneleri yapıldı. RDUS ile elde edilen Rİ değerlerinin peritoneal diyaliz sırasında yükselmediği belirlendi.

Sonuç olarak, RDUS ve GSU kombinasyonunun böbrek hastalıklarının değerlendirilmesinde faydalı olduğu ve obstrüktif renal hastalıklarda Rİ artışının peritoneal diyaliz ile önenebileceği belirlendi.

**Anahtar sözcükler:** Köpek, Böbrek, Rezistiv indeks, Üreteral obstrüksiyon

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### İletişim (Correspondence)

Phone: +90 474 2426800/1251

e-mail: ahkirmizigul@hotmail.com

## INTRODUCTION

Traditional imaging techniques fail to efficiently diagnose urinary diseases. Gray Scala Ultrasonographic (GSU) technique is a very sensitive method regarding early detection of dilatations related to urinary tract lesions. However, the information obtained by GSU about the etiology of the dilatation, and physiologic and patophysiological status of kidneys is insufficient<sup>1-3</sup>.

Color Doppler Ultrasonography (CDUS) gives information about the physiological status of the kidney as well as the diagnosis of various pathophysiological events through the determination of renal blood flow changes. These haemodynamic changes are some of the doppler parameters used in the determination of resistance alterations in the intrarenal vessels. Resistive Index (RI) value is defined as a potentially strong supplementary parameter in the detection of renal diseases with increasing or decreasing renal vascular resistance. Various pathophysiological states of the kidneys may be differentiated according to alterations in RI value<sup>1,4-6</sup>.

Through the measurement of RI value of the kidneys, substantial information may be obtained about renal diseases such as acute obstructive uropathy, non-obstructive and obstructive dilatation, renal arterial stenosis, allograft rejection, haemolytic uremic syndrome, and acute tubular necrosis. CDUS provides a non-invasive and painless procedure and requires no ionized radiation or intravenous contrast substances. It is also more advantageous regarding other diagnostic modalities<sup>7-11</sup>.

The purpose of this study was to investigate the effect of peritoneal dialysis, induced for the clearance of metabolites in the blood and maintenance of blood biochemical status after experimental ureteral obstruction, and on RI value that reflects pathologic and physiologic changes in kidneys.

## MATERIALS and METHODS

*Animals:* Six mongrel dogs were (3 female and 3 male; age 2 to 7 years; body weight 11 to 25 kg) included into the study. Experimental and study design were approved by the Ethical Committee of Faculty of Veterinary Medicine, Ankara University.

*Anesthesia Protocols:* Premedication was main-

tained by administration of 0.1 ml/kg of Xylazine HCl (23.32 mg/ml, Rompun, Bayer®). Renal morphology was initially evaluated by GSU. This was followed by RI value acquisition by CDUS from arcuate arteries on the corticomedullary border of right and left kidneys. General anesthesia was maintained by ketamine hydrochloride (Ketalar, Eczacibasi®; 10 mg per kilogram of body weight).

*Surgical Procedures:* An incision of 5 cm in length was made on the left paramedian line, 10 cm caudal to the sternum. Partial omentectomy was accomplished through the removal of omentum majus. Ureters of both kidneys were then reached. Complete proximal ureteral obstruction was achieved afterwards through the utilization of clips within the integral set (Rush®, Cat No:335009) used in human medicine. After that, the tip of permanent Tenckhoff catheter was placed in caudal abdomen within close proximity to the pelvic canal and fixed to the peritoneal wall. Its free end was left outside the body. Abdominal wall was closed according to routine procedures.

Blood was collected from all animals to measure BUN and creatin values. Peritoneal dialysis was initiated when BUN value exceeded 30 mmol/L. Dialysis was continued for two days at a 6 hour interval. Eight sessions were carried out for every animal. Gray Scala and Color Doppler Ultrasonography of right and left kidneys was performed every 24 hours before the ureters were ligated, during the waiting period for BUN level to exceed 30 mmol/L, and after the initiation of dialysis.

The dogs were operated afterwards and the clips and Tenckhoff catheter were removed. Abdominal wall closure was made in routine manner.

Following the removal of clips from ureters, GSU and CDUS examinations of both kidneys of the each dog was carried out on first, 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> days after the procedures. Statistical analysis of the results was carried out by Friedman test.

## RESULTS

Clinical signs of depression, weakness, dullness and vomiting were observed in the dogs during the period from the ligation of ureters to dialysis. The animals showed diverse affinity towards food and water. They consumed considerable amount of water

between 30<sup>th</sup> and 39<sup>th</sup> hours at various intervals. Affinity towards food generally decreased.

BUN level criterion (30 mmol/L) required for the initiation of peritoneal dialysis was reached in different times. BUN level exceeded 30 mmol/L in 30<sup>th</sup> hour in the dog No.1; in 33<sup>th</sup> hour in dogs No.4; 36<sup>th</sup> hour in dogs No.2, 3, and 6; and in 39<sup>th</sup> hour in dogs No.5.

Peritoneal dialysis was started when BUN level reached 30 mmol/L. Following peritoneal dialysis, clinical symptoms regressed. There was a significant ( $P<0.05$ ) increase between preoperative values and the initial values at the first session, and a significant decrease ( $P<0.05$ ) was detected for BUN values when compared to the initial and final values of each session. When initial RI values were compared with the values pertaining to the first and 2<sup>nd</sup> days following bilateral complete obstruction via ureteral clips, a significant ( $P<0.001$ ) increase was observed between the initial measurement and RI values recorded on 1<sup>st</sup> and 2<sup>nd</sup> day. There was no increase in RI values obtained at 1<sup>st</sup> and 2<sup>nd</sup> day following peritoneal dialysis the value remained constant. However, RI values recorded on these days showed an apparent increase compared to initial RI values ( $P<0.001$ ) (Fig. 1-3).

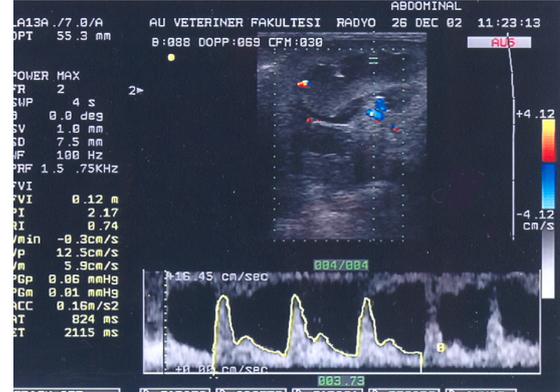
Following the last peritoneal dialysis treatment, the RI value obtained from both kidneys one day after the removal of clips was significantly higher than initial RI value ( $P<0.001$ ). There were no marked differences for RI values recorded on 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> days after the removal of clips. However, the significant difference between them and initial RI value remained ( $P<0.001$ ). A statistically suggestive ( $P<0.001$ ) decrease was observed between RI values of the last



**Fig 1.** Resistive index value by Color Doppler Ultra-sonographic examination before clips were placed on ureters.

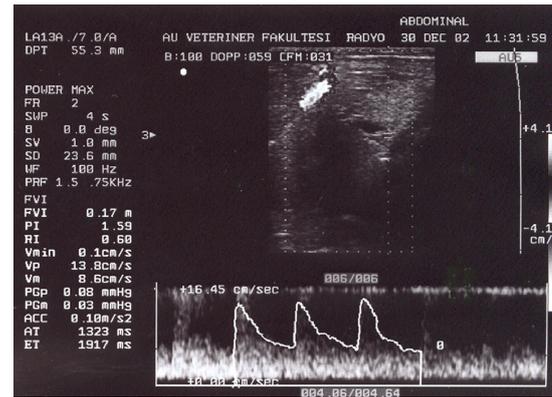
**Şekil 1.** Üreterlere klips yerleştirilmeden önce yapılan renkli doppler ultrasonografik muayenede rezistiv indeks değeri.

days of peritoneal dialysis and RI values of first, 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> days after clip removal (Fig. 4).



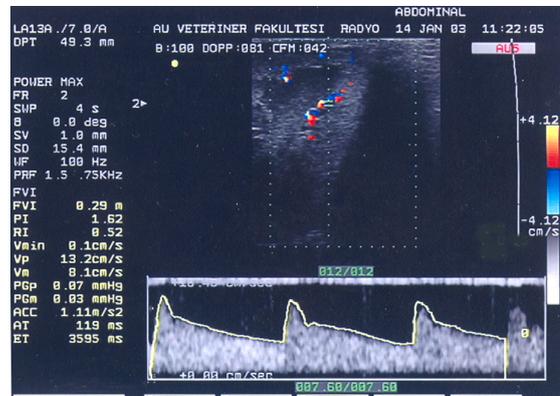
**Fig 2.** Determination of resistive index by Color Doppler Ultrasonographic examination after clips location on ureters before peritoneal dialysis.

**Şekil 2.** Peritoneal diyalizden önce üreterlere klips yerleştirilerek yapılan renkli doppler ultrasonografik muayenede rezistiv indeks belirlenmesi.



**Fig 3.** Determination of resistive index with Color Doppler Ultrasonographic examination during peritoneal dialysis.

**Şekil 3.** Peritoneal diyaliz esnasında yapılan renkli doppler ultrasonografik muayenede rezistiv indeks belirlenmesi.



**Fig 4.** Resistive index value by Color Doppler Ultrasonographic examination on the 15th day after removal of clips.

**Şekil 4.** Klipslerin çıkarılmasından 15 gün sonra renkli doppler ultrasonografik muayenede rezistiv indeks değeri.

## DISCUSSION

Kidneys are important organs regarding elimination of metabolic waste, and the maintenance of electrolyte and acid-base homeostasis. Knowledge of urine production and elimination is necessary for the evaluation of urinary tract diseases<sup>12</sup>.

In acute obstructions, severe pain is present due to distention of renal capsula or the collective system. If complete obstruction is present in both ureters, symptoms of uremia may be extremely intense. Symptoms of anorexia, dullness, and gastrointestinal system accompany pain<sup>13</sup>.

Pain, depression, dullness, apathy and vomiting was observed in our study group after ureteral ligation until the initiation of peritoneal dialysis. There were individual differences among dogs with regards to their interest in food and water. All dogs consumed considerable amount of water from the 30<sup>th</sup> hour following ligation until the 39<sup>th</sup> hour and interest to food was undesirable.

Dialysis is a treatment method of elimination of toxic materials that may be a risk for the life of a patient and distress physiological structures. Its primary application fields are fluid, hydrogen and electrolyte imbalances and uremia resulting from renal failure. In patients with severe renal failure, homeostasis is achieved by means of dialysis by correcting of the secretory functions of kidneys. Peritoneal and haemodialysis are the most common dialysis techniques which are the same in principle and purpose of the treatment. Patients with acute uremia lose their lives without any progress in their kidneys if they're not immediately treated with dialysis<sup>11,14,15</sup>. It is required to bring down the BUN level under 30 mmol/L in peritoneal dialysis applications<sup>15</sup>.

Following the ligation of ureters, BUN level was measured in all cases by 3 hour intervals. Peritoneal dialysis was initiated when BUN level exceeded 30 mmol/L. However, there were differences in surpassing the 30 mmol/L in all of the dogs. This particularly occurred between the 30<sup>th</sup> and 39<sup>th</sup> in the present study. After initiation of peritoneal dialysis, a pronounced decrease was observed in BUN levels at the end of every session compared to the previous one. Accompanying this fall, a marked improvement

in the clinical states of the dogs was monitored. There was a significant rise ( $p < 0.05$ ) from preoperative BUN level to the first session of peritoneal dialysis level. Furthermore, statistically significant ( $p < 0.05$ ) decreases in BUN levels were detected when compared to the values obtained from initial and the end of every session.

Gray Scala Ultrasonographic examinations provide valuable information about the anatomy and morphology of the kidneys. It is therefore, the primary diagnostic method for determination of renal diseases<sup>1,2,4-7</sup>. Each dog was ultrasonographically examined at the beginning of, and during the study. The most pronounced finding between the initial sonograms and the images obtained after clip placement was a slight dilatation in renal pelvis and the ureteral exit. No disorders in parenchymal tissue were encountered for all cases.

It is reported that kidneys can fully recover if the hydronephrosis is solved within one week after the complete obstruction if there is no infection or other kidney damage<sup>16</sup>. There was a four day period between placing the clips over the ureters of the dogs and creating ureteral obstruction and removal of the clips. That's why, no pathological disorders were encountered in the kidneys anatomically and morphologically on the post operative of first, 5, 10 and 15<sup>th</sup> days.

In order to maintain sufficient blood flow to kidneys, blood must be of adequate pressure and there should not be any anomalies on renal arteries<sup>17</sup>. Renal blood flow is also affected by cardiac output, circulation volume, and systemic vascular resistance<sup>12</sup>. The functions of the kidneys may be evaluated by CDUS In order to achieve this, blood flow in intrarenal blood vessels is measured<sup>2,4,8,18-20</sup>. Usually, RI value which is the characteristic barometer of vascular resistance is evaluated in intrarenal doppler. Obstructive nephropathy and declines in renal perfusion can be definitely diagnosed by RI<sup>2,4,7,21,22</sup>.

There was a significant increase between the preoperative RI values and RI values obtained after complete obstruction through clips placement ( $p < 0.001$ ). According to the previous studies, RI values increase in kidneys with complete obstruction and this is as-

cribed to vascular resistivity in the kidneys<sup>6,10,20,22</sup>. On the 3<sup>rd</sup> and 4<sup>th</sup> days of peritoneal dialysis, RI values were not higher than 1<sup>st</sup> and 2<sup>nd</sup> days following obstruction, the values were constant. However, there was a marked increase when compared to preoperative value ( $P < 0.001$ ). This increase for renal arteries is an evident indication of obstruction. Vascular resistivity is impaired in the case of obstruction. There have been no studies encountered related to Color Doppler findings that reflect physiological and pathophysiological changes in the kidneys during dialysis in humans and animals. RI value was still high during peritoneal dialysis since the resistance on renal arteries was present in the event of complete obstruction.

RI value as an important parameter in color doppler examination of kidneys is widely used as a clinical finding in the evaluation of renal disfunctions related with physical factors underlying kidney abnormalities<sup>2,5,10,18,22</sup>.

RI values were higher at the time of clips removal compared to the preoperative values ( $P < 0.001$ ). This suggested that blood flow was not regulated due to obstruction and a availability of a resistance in renal arteries. There was no difference between the 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> day values after clip removal, however, they were higher with regards to the levels at the beginning of the study ( $P < 0.001$ ). There was significant drop for RI values pertaining to the last days of peritoneal dialysis compared to the RI values of 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup>, and 15<sup>th</sup> days after removal ( $P < 0.001$ ). This may indicate that the renal vascular resistance regressed in time and sufficient amount of blood was supplied.

In conclusion, information obtained during ultrasonographical examination of renal disfunctions remains insufficient although it is an indispensable method regarding its noninvasive nature and real-time anatomical information. Therefore, it may be more helpful to combine with Color Doppler Ultrasonography which provides valuable information on renal blood flow when evaluations of renal diseases are required. RI value increases in obstructive renal diseases and this can be obviated by peritoneal dialysis during obstruction.

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