SUMMARY

Contributions in evaluating renal ultrasound changes in some renal diseases in dogs by measuring vascular renal indexes
PhD student: Constantinescu Radu

Scientific coordinator: *Professor Dr. Crivineanu Victor*

Key words: *renal disease, TRU-Cut biopsy, ultrasound, pulsatility index, resistive index, B mode, Color Doppler mode, kidneys.*

The PhD thesis entitled **"Contributions in evaluating renal ultrasound changes in some renal diseases in dogs by measuring vascular renal indexes"** is elaborated and structured in two parts, according to legislation, comprising, in the first part the bibliographic study and in the second part, personal research. In this thesis, in the first part, the bibliographic study was aimed at updating scientific literature data, concerning renal anatomy and physiology and, also, the main aspects of renal functional and structural disease. The bibliographic study has six chapters and represent about 23% of the total thesis.

The second part of the thesis represents the personal research, being an original work, having six chapters: *Chapter VII* Materials and methods, *Chapter VIII* Study of Doppler ultrasound evaluation of kidneys un dogs without changes of renal efficiency, according to age, *Chapter IX* Study of the Doppler ultrasound evaluation of kidneys in dogs without changes of the renal function, according to their hydration status, *Chapter X* Study of the ultrasound evaluation of kidneys in dogs with various pathologic processes that cause obstructive urological diseases, *Chapter XI* Study of ultrasound evaluation of kidneys in dogs diagnosed with chronic kidney disease and *Chapter XII* General conclusions. Personal research represents about 77% of the thesis, having a number of 31 tables, 121 figures and 20 graphs. At the end of the personal research there are the general conclusions, as well as references, a number of 29 and, respectively, 381.

According to the new national and international tendencies and to the technological evolution of ultrasound machines, in the second part of this paper, subjects about renal eco-anatomy were addressed, while also evaluating ultrasound changes in some renal diseases by measuring the renal vascular indexes. Also, an evaluation of the personal research took place, by actually implementing my own technique for Color Doppler ultrasound examination, by

measuring the renal vascular indexes in dogs, in the context in which renal functionality is highly influenced by the physical characteristics of hemodynamics and, also, by the complexity of the interdependence of the renal system with the endocrine system and, mostly, with the circulatory system.

Dynamic and thorough monitoring of renal diseases implies a corroboration between clinical, paraclinical aspects and the ones offered from evaluating structural aspects of renal morphology, which gives imaging examinations an important role in obtaining additional information and, also, a very important role by being minimally-invasive in taking biopsy samples.

Through ultrasound examinations in B mode and Color Doppler mode, in the second part of the thesis, the personal research part offers the possibility of evaluating two aspects: viewing of the renal architecture, of possible pathologic and/or incidental findings and information about the vascular architecture and physical hemodynamic aspects of renal trophic vascularization, by calculating vascular indexes, like the resistive index and the pulsatility index.

Due to the fact that in the past years, in human medicine, by calculating renal vascular indexes there have been found many correlations between different types of renal disease and the progress of prognosis for patients with renal conditions, and also due to the lack of scientific data regarding this subject in veterinary medicine, the aim of this thesis is one of real interest and a topical issue for determining the values of renal vascular indexes in some renal conditions in the dog.

In the first part of *Chapter VII* the physical principles of ultrasound examinations are widely presented, the two ultrasound modes used for all the patients in this study (B mode and Color Doppler), how to optimize and adjust the ultrasound machine settings, both in B mode and Color Doppler mode, in order to increase the image quality of the examined structures and in order to increase the accuracy of hemodynamic data. The second part of this chapter describes the ultrasound examination technique, used in a systematic manner and, also, the corresponding anatomical structures in ultrasound image representations of renal structures, both in B mode, Color Doppler mode, Power Doppler directional and Pulsed Doppler. In the third part of this chapter is presented the biochemical blood analysis, which all patients of this study sustained before taking part in the abdominal ultrasound examination. In the last part of this chapter are presented aspects of computed tomography examinations, by describing the work method used for patients in this study.

The renal vascular resistivity and pulsatility can be influenced by characteristics of the examined blood vessel (diameter, blood flow, blood volume, arterial wall elasticity, heart rate, blood pressure, blood osmolarity), by extra-vascular factors (the density of peri-tubular vascular

tissue, degree of dehydration) and also by renal morphological characteristics. Thereby, the first study was made on dogs without changes in renal function, according to different age categories, in four groups (group I - young animals: 1 month-4 months, group II - young animals: 4 months-1 year, group III - adults: 1 year-7 years and group IV - geriatrics: 7 years-13 years). This study is part of *Chapter VIII,* being of an observational sort and was later considered to be a reference lot for mean physiological values of resistive and pulsatility indexes, determined at the level of interlobar renal arteries of the left and right kidneys and, also, at the level of the left renal artery. Also, for all four age groups the same ultrasound aspects were monitored, in B mode ultrasound examinations, such as analysis of renal shape, parenchymal echogenicity, distinction between cortex and medulla, kidney length, ratio between renal cortex and medulla, as well as other aspects with a potential pathologic and/or incidental aspect. In this study, the analysis of data obtained for all four groups, on different age categories, revealed the fact that differences in values for the resistive index calculated at the level of the left kidney are statistically significant. The same tendency appears also when the groups are analyzed in a two-by-two manner, the slightest difference being between the groups of adults and geriatrics. Results obtained for the resistive index at the level of the right kidney are similar with the ones obtained for the left one. The differences between groups, both generally and when taken in a two-by-two method have been statistically significant. The values for the resistive index at the level of left renal artery had a similar result as the ones obtained before, having statistically significant differences between different age groups and between groups of similar age, the highest value being the one between the groups of adults and geriatrics.

These aspects prove the direct influence of the subjects' age on the physiological values of the resistive index at the level of the right and left kidney and the left renal artery, differences between values being higher for groups in the first age period and lowered as patients grow older.

In *Chapter IX,* starting from the hypothesis that changes in the patient's hydration status influence the renal blood flow, renal indexes in clinically healthy dogs and without biochemical changes have been manually calculated, in order to show the existence or non-existence of a connection between the two aspects and, also, the possible involvement of extra-renal factors over renal hemodynamics. Thus, in this observational study were included only dogs that presented with a clinical status of dehydration, which had no alterations of biochemical parameters that indicated no functional renal pathologies, for all of them being calculated afterwards the blood osmolality and the renal indexes before and after hydration. These changes of renal vascular resistivity and pulsatility suggested the fact that the values of renal indexes are directly influenced by the hydration status.

Chapter X of this paper addresses ultrasound examinations of kidneys in dogs with several pathologies that induce obstructive urological diseases, being divided in two groups, depending on the presence or absence of alterations of biochemical parameters. For the patients in this chapter it was observed that for 66.7% of the kidneys that presented with some degree of hydronephrosis observed during the ultrasound examination, there was an increase in vascular index values, compared to the mean value of the reference lot, according to age, and of them, 23.08% had increased resistive index values for the other kidney. Also, for 50% of patients with different degrees of bilateral hydronephrosis observed during the ultrasound examination there was an increase in the values of the resistive index in both kidneys. Thus, determining the renal resistivity and pulsatility has an increased sensibility in obstructive renal disorders.

In *Chapter XI,* this observational retrospective study for dogs diagnosed clinically and paraclinically with chronic kidney disease, which had a definitive histopathologic diagnosis was carried out due to encouraging results obtained in human medicine and to multiple applications and correlations found for renal vascular indices for patients with chronic kidney diseases. Because there are few studies in veterinary medicine concerning renal vascular evaluation of patients with chronic kidney disease, the main goal of this study was to observe any changes of renal vascular indices and of spectral waveforms of arterial hemodynamics, as well as possible correlations between histological pathological renal lesions and renal vascular indices. Thus, this study included 24 dogs, all of which had a definitive histopathologic diagnosis, after examining biopsy samples taken ante-mortem by Tru-Cut technique, or post-mortem.

By determining the values of renal vascular indexes for patients with chronic kidney disease there were found sensibly similar values with the ones obtained for the reference lot.

The histopathologic exam of patients with spectral waveform of tardus parvus revealed impaired tubular and glomerular structures in a percentage of 66.7% and impaired renal interstitial structures in a percentage of 33.3%. Spectral waveforms for all patients with severely impaired interstitial structures were characterized by excessive increase of telesistolic maximal velocity, compared with the telediastolic velocity, shortening of the systolic acceleration time and telediastolic relaxation time, occurrence of the shock wave and/or retrograde blood flow. Also, ultrasound guided biopsies by Tru-Cut automatic/semiautomatic technique had no post-interventional complications in 78.5% of the cases and only for 14.2% of them there were some complications.

Primary, in this scientific work, the study started by determining the physiological values of renal vascular indexes for healthy dogs, according to different age groups, being afterwards used as reference values for patients with several renal pathologies. This study is highly important because of it's authenticity given by calculating renal indices at the level of the

interlobar arteries, by eliminating errors given by shifting of the insonance Doppler angle degree and because it proves the direct involvement of the hydration status over the increase of the resistive and pulsatility indexes. The usefulness of the two indices as sole indicators for a diagnosis hasn't been proven in this study, but their variation can be used as an aspect of a possible renal disease diagnosis. Another original part of this study is the one regarding the fact that the right kidney had more stable variations of renal indices in obstructive pathologies, being a more useful diagnosis indicator, compared to the left kidney. Also, for patients with chronic kidney disease it was observed that the main change in Color Doppler ultrasound examination was the one of the vascular spectral waveform.

Unlike in human medicine, in this study there are no correlations between values of the two indices in different renal pathologies, even if the degree of specificity increased along with the increase in severity of the renal pathologic process. Overall, it was observed that correlation between changes in the B mode ultrasound examination along with renal vascular indexes values and spectral waveforms of interlobar arteries are all particular aspects in establishing a diagnosis of possible renal diseases.

In *Chapter XII* are presented the main conclusions that can be taken out of the statistical analysis of data obtained in the four chapters and, also, summary conclusions.

The present study has originality and brings novelty in the veterinary national literature, concerning renal ultrasound examination by determining renal vascular indexes in both physiological conditions and in the case of extra-renal factors or renal several renal diseases.