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● *Clinical Note*

QUANTITATIVE ANALYSIS OF FOUR TYPES OF PRIMARY GLOMEROPATHY BY APPLICATION OF A DECISION FOREST TO ULTRASONIC AND LABORATORY CHARACTERISTICS

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Abstract—The aim of this study was to apply a decision forest to analysis of the ultrasound characteristics and laboratory test indices of four types of primary glomerulopathy, and quantitative analysis of the four pathologic types using a combination of these two methods. The decision trees were derived from 41 clinical indices and 5 characteristic sonographic indices obtained for the left kidney. Fifty-six patients who had undergone ultrasound-guided renal biopsy were reviewed retrospectively, and on pathologic examination, the patients were diagnosed with primary glomerulopathy, which includes mesangial proliferative glomerulonephritis, membranous nephropathy, immunoglobulin A nephropathy and minimal change disease. In this study, eight characteristic indicators were correlated with pathologic type in the 56 cases of primary glomerulopathy. The order calculated by decision forests, from high to low, is proteinuria, length of kidney, serum creatinine, plasma albumin, area of kidney, total protein, thickness of renal parenchyma, 24-h urine protein. The glomerulopathy with the highest ++++ proteinuria is membranous nephropathy, which accounts for 39.2% (22/56) of the total sample; this was followed by minimal change disease, mesangial proliferative glomerulonephritis and immunoglobulin A nephropathy. On the basis of our analysis of 41 clinical indices, the key indices for quantitative analysis of primary glomerulonephritis are laboratory tests, and these include urine protein, serum creatinine, plasma albumin, total serum protein and 24-h urine protein. The three key sonographic features are measurement indices: renal length, renal area and renal parenchymal thickness. From the eight characteristic indicators, we observed that with respect to severity (from most severe to least severe), the four types of glomerulopathy are membranous nephropathy, minimal change disease, mesangial proliferative glomerulonephritis and immunoglobulin A nephropathy. (E-mail: syycsk@163.com) **© 2014 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Decision forests, Primary glomerulopathy, Renal biopsy, Clinical laboratory indices, Ultrasonographic characteristics.**

INTRODUCTION

Glomerular diseases can be classified into primary, secondary and hereditary glomerulopathies; most glomerular diseases are primary glomerulopathies. Mesangial proliferative glomerulonephritis (MsPGN), membranous nephropathy (MN), minimal change disease (MCD) and immunoglobulin A nephropathy (IgAN) are the four common pathologic types of primary glomerulopathy. The first three often present clinically as nephritic syndrome, with a 24-h urine protein >3.5 g and a plasma albumin <30 g/L. Fifteen percent of patients with IgAN present with nephritic syndrome; the remainder most often present with repeated hematuria or proteinuria. Clinical laboratory indices usually constitute the basis for diagnosis of glomerulopathy, and serum creatinine is one of the most frequent renal function tests. D'Amico (1998) reported that serum creatinine is relatively closely related to glomerular injury, and its value is correlated positively with the degree to which glomeruli are injured. Renal ultrasonography is also an important supplementary method in the diagnosis of glomerulopathy.

In recent years, with the advances made in ultrasonography and, thus, substantial improvement in the quality of ultrasonic images, the structure of the kidney has been revealed more clearly; even 2-D ultrasonic images can usually reveal pathologic changes in renal parenchyma (Martinoli et al. 1999). Therefore, renal

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ultrasound examination is usually the first-line radiologic examination in the presence of such symptoms as proteinuria, hematuria or renal failure (Huntington et al. 1991). Moreover, with development of the disease, changes in the size of the kidney and the echo of renal parenchyma in the sonogram become more obvious (Di Nardo et al. 1989; Tikkakoski et al. 1994). On the one hand, the traditional view is that the length of the kidney is associated with renal function in patients with chronic renal diseases, and there are many reports on the clinical value of kidney length in ultrasonic images (American Institute of Ultrasound in Medicine [AIUM] 2008). In a study comparing ultrasonic images with pathologic results for the kidney, Buturović-Ponikvar and Visnar-Perovic (2003) proved that there is an important correlation between kidney length and glomerulosclerosis or tubular atrophy. On the other hand, Beland et al. (2010) recently reported that the thickness of the renal cortex is more sensitive than kidney length in the evaluation of the renal function in chronic renal diseases on the basis of sonograms. Although these sonogram indices have been found to be helpful in the diagnosis of glomerulopathies, criteria for the prediction of pathologic changes in renal parenchyma from ultrasonic indices have not been established (Moghazi et al. 2005). Furthermore, most of the aforementioned studies were concerned with comparisons between kidneys with glomerulopathy and normal kidneys; studies of relationships between different types of glomerulopathy are rare.

We used a decision forest to calculate and analyze 46 indicators related to the types of glomerulopathy. Decision forest is an innovative ensemble decision approach and can be used efficiently to perform multiple gene mining tasks developed by our team (Li et al. 2004). Establishment of this analytical strategy has offered the promise of advancing microarray technology as a means of deciphering the involved indicators of complex diseases. This is the first time we used a decision forest to analyze glomerulopathies; at the same time, we sought to determine the level of severity of the four pathologic types.

METHODS

Material

The cases of 56 inpatients of the First Hospital of Harbin who had undergone ultrasound-guided renal biopsy from July 2008 to February 2011 were reviewed retrospectively. There were 24 male and 32 female patients ranging in age from 15 to 74 (average: age 35 ± 7.9). Of the 56 patients, 23 (41.1%) had been diagnosed with MsPGN, 15 (26.7%) with MN, 9 (16.1%) with MCD and 9 (16.1%) with IgAN. None of the 56 patients had other renal diseases or an absolute contraindication to renal needle biopsy.

Relevant examination and test indices

The 46 indices comprise 41 clinical indices and 5 characteristic sonographic indices. The 41 clinical indices are: sex; age; routine urine tests (hematuria, proteinuria, casts, specific gravity); medical history (pharyngitis, cold, skin infection, secondary diseases, history of hepatitis); renal function (creatinine, urea nitrogen, uric acid, binding rate of CO_2); weight (kg); family history; medication history; allergy history; blood biochemistry (total protein [TP], albumin [ALB], globulin [GB]); liver function; blood glucose; blood lipids; blood coagulation; platelets; hemoglobin; complement C3/C4; five tests for hepatitis B (HBSAg, HBSAb, HBeAg, HBSAb, HBcAb); hereditary disease; SSA and SSB antibodies; double-stranded DNA; anti-nuclear antibody; immunoglobulin and 24-h urine protein. The five sonographic imaging findings are long diameter, transverse diameter, area, cortical echo and parenchymal thickness of the left kidney. For all 46 indices, lower than normal, normal and higher than normal values are designated as –1, 0 and 1, respectively; an omitted index is represented by a dash, and negative and positive indices are designated by minus and plus signs, respectively.

Ultrasonic equipment and biopsy instruments

We used the MyLab90 (MyLab GOLD Platform) color Doppler ultrasonic diagnosis set (Esaote, Genoa, Italy) with puncture guiding frame, with an abdominal probe frequency of 3.5 MHz; an automatic biopsy gun (range: 1.5–2.0 cm, manufactured in Japan); a 16 G × 20 cm disposable biopsy needle (manufactured in Japan); hemocoagulase (Bangting) for injection 1 kU/ampoule (manufactured in China, National Medicine Permit H20041730), an intramuscular hemostatic agent; and flurbiprofen axetil (Kaifen) for injection 50 mg/ampoule (manufactured in China, National Medicine Permit H20041508), an analgesic administered by intravenous drip.

Ultrasonic examination and needle biopsy

The length and width of the left kidney, that is, the long diameter and transverse diameter where the cross-sectional area was maximum, were measured in the routine ultrasonic examination. The area of the kidney was calculated by multiplying kidney length by kidney width (Supplemental Fig. A) (Whittier et al. 2004). All patients signed an inform consent, agreeing to participation in the research project. The informed consent was signed before the needle biopsy. The procedure was approved by the ethics committee. The patient was placed in the prone position with a pillow placed dorsally, slightly superior to the iliac crests. The lower pole of the left kidney was selected as the puncture point. Patients were told to hold their breath during the piercing process (usually with