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THE ROLE OF URINE β2-MG CONCENTRATION AND THE URINE MAU/UA RATIO IN THE DIAGNOSIS AND RISK STRATIFICATION OF HYPERTENSION-INDUCED RENAL DAMAGE

ULOGA KONCENTRACIJE β2-MG U URINU I ODNOSA MAU/UA U URINU U DIJAGNOSTICI I STRATIFIKACIJI RIZIKA OŠTEĆENJA BUBREGA IZAZVANOG HIPERTENZIJOM

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Summary

Background: To explore the roles of urineβ2-microglobulin (β2-MG) and the ratio of microalbuminuria (MAU) to uric acid (UA) in the diagnosis of renal damage and risk stratification assessment of the prognosis of essential hypertension with H-type (EH) hypertension.
Methods: From January to December 2025, 204 patients with H-type EH and renal damage who were admitted to our hospital were selected and included in the renal damage group, whereas 102 patients with H-type EH but without renal damage were included in the EH group. Baseline data for all patients were collected. Urine β2-MG, urinary MAU, and UA levels were measured in all patients,

Kratak sadržaj

Uvod: Cilj je bio da se ispita uloga β2-mikroglobulina (β2-MG) u urinu i odnosa mikroalbuminurije (MAU) i mokraćne kiseline (UA) u dijagnostici oštećenja bubrega i proceni stratifikacije prognostičkog rizika kod bolesnika sa esencijalnom hipertenzijom H-tipa (EH).
Metode: U periodu od januara do decembra 2025. godine odabrana su 204 pacijenta sa H-tip EH i oštećenjem bubrega, hospitalizovanaih u našoj ustanovi, koji su uključeni u grupu sa oštećenjem bubrega, dok su 102 pacijenta sa H-tip EH bez oštećenja bubrega uključena u EH grupu. Prikupljeni su početni podaci svih pacijenata. Određivani su nivoi β2-MG u urinu, MAU u urinu i UA, i

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and the MAU/UA ratio was calculated. The β2-MG levels and MAU/UA ratios of the two groups were compared, and multivariate logistic regression was used to identify factors influencing renal damage in patients with H-type EH. Patients with EH-related renal damage were divided into a low- to moderate-risk group and a high-risk group based on the prognostic risk stratification at admission. A receiver operating characteristic (ROC) curve was constructed to assess the predictive value of urine β2-MG concentration and the urine MAU/UA ratio for prognostic risk stratification of H-type EH renal damage.

Results: Compared with those in the EH group, the proportion of patients with renal damage combined with diabetes, the urine β2-MG level, and the urine MAU/UA ratio were significantly greater ($P<0.05$). The results of multivariate logistic regression analysis revealed that elevated urine β2-MG levels and the urine MAU/UA ratio were independent risk factors for renal damage in H-type EH patients ($P<0.05$). The prognostic risk stratification revealed that 122 patients were in the low- to moderate-risk group and 82 in the high-risk group; urine β2-MG levels and urine MAU/UA ratios in the high-risk group were significantly higher than those in the low- to moderate-risk group ($P<0.05$). The ROC curve analysis revealed that the individual and combined predictions of urine β2-MG concentration and the urine MAU/UA ratio for high-risk renal damage in H-type EH patients had AUC values of 0.781, 0.786, and 0.860, respectively. The combined prediction AUC was significantly greater than the individual prediction AUC of the urine β2-MG concentration and the urine MAU/UA ratio ($Z=2.035$, 1.953; both $P<0.05$).

Conclusion: The urine β2-MG level and urine MAU/UA ratio in patients with H-type EH renal damage are high. Moreover, increases in urine β2-MG levels and the urine MAU/UA ratio are independent risk factors for renal damage in H-type EH patients. The combined detection of these two indicators has high predictive value for the risk stratification assessment of renal damage in H-type EH patients.

Keywords: primary H-type hypertension, renal damage, β2-microglobulin, microalbuminuria, uric acid, prognostic risk stratification

izračunat je odnos MAU/UA. Upoređeni su nivoi β2-MG i odnos MAU/UA između dve grupe, a multivarijantna logistička regresiona analiza korišćena je za ispitivanje faktora koji utiču na pojavu oštećenja bubrega kod pacijenata sa H-tip EH. Pacijenti sa EH-povezanim ošteć enjem bubrega podeljeni su, prema prognostičkoj stratifikaciji rizika pri prijemu, na grupu niskog do umerenog rizika i grupu visokog rizika. Konstruisana je ROC kriva radi analize prediktivne vrednosti koncentracije β2-MG u urinu i odnosa MAU/UA u urinu za procenu prognostičke stratifikacije rizika oštećenja bubrega kod H-tip EH.

Rezultati: U poređenju sa EH grupom, u grupi sa ošteć enjem bubrega zabeležen je značajno veći udeo pacijenata sa pridruženim dijabetesom, kao i značajno viši nivo β2-MG u urinu i veći odnos MAU/UA ($P<0,05$). Multivarijantna logistička regresiona analiza pokazala je da su povišen nivo β2-MG u urinu i povećan odnos MAU/UA nezavisni faktori rizika za nastanak oštećenja bubrega kod pacijenata sa H-tip EH ($P<0,05$). Rezultati prognostičke stratifikacije pokazali su da je 122 pacijenta svrstano u grupu niskog do umerenog rizika, a 82 u grupu visokog rizika; nivo β2-MG u urinu i odnos MAU/UA bili su značajno viši u grupi visokog rizika nego u grupi niskog do umerenog rizika ($P<0,05$). ROC analiza pokazala je da pojedinačna i kombinovana predikcija koncentracije β2-MG u urinu i odnosa MAU/UA za visokorizično oštećenje bubrega kod H-tip EH ima AUC vrednosti 0,781, 0,786 i 0,860, respektivno, pri čemu je AUC kombinovane predikcije bio značajno veći u odnosu na pojedinačne AUC vrednosti za β2-MG i MAU/UA ($Z=2,035$; 1,953; oba $P<0,05$).

Zaključak: Nivo β2-MG u urinu i odnos MAU/UA kod pacijenata sa H-tip EH i oštećenjem bubrega su povišeni. Povećanje nivoa β2-MG u urinu i odnosa MAU/UA predstavlja nezavisne faktore rizika za nastanak oštećenja bubrega kod ovih pacijenata. Kombinovano određivanje ova dva pokazatelja ima visoku prediktivnu vrednost za procenu stratifikacije rizika oštećenja bubrega kod bolesnika sa H-tip EH.

Ključne reči: primarna hipertenzija H-tipa, oštećenje bubrega, β2-mikroglobulin, mikroalbuminurija, mokraćna kiselina, stratifikacija prognostičkog rizika

Introduction

Primary hypertension (EH) is a common cardiovascular syndrome in clinical practice. Patients with EH present with elevated systemic arterial pressure, which is often accompanied by abnormal glucose and lipid metabolism and damage to the heart, brain, kidneys, and blood vessels. The kidneys are the main target organ affected (1–2). H-type EH refers to EH patients with high β2-microglobulin (β2-MG)emia. H-type EH is an important risk factor for the development of kidney disease and is prone to cause renal impairment. Early symptoms include increased renal vascular resistance. If not diagnosed and treated in time, it can progress to end-stage renal disease, increasing the risk of death for patients (3–4). Therefore, early, accurate diagnosis of renal damage in H-type EH and assessment of its prognostic risk are key to improving therapeutic outcomes and patient prognosis.

β2-MG is an intermediate metabolite of methionine. Previous studies have shown that β2-MG is significantly correlated with early renal function impairment in hypertension (5). The uric acid (MAU)/uric acid (UA) ratio is an important indicator for the clinical judgment of early renal function impairment. Since MAU is easily affected by urine volume, after calibration with UA, the MAU/UA ratio can be used to evaluate urine MAU excretion (6–8) objectively. Studies have shown that the MAU/UA ratio has good predictive value for renal impairment in pregnancy-induced hypertension and can be used to assess its severity (9–11).

Based on the above research, it is speculated that the β2-MG/MAU/UA ratio has a reference value for diagnosing and assessing prognostic risk in H-type EH renal damage. Therefore, this study further analysed the roles of urine β2-MG concentration and the urine MAU/UA ratio in the diagnosis and prognostic risk stratification of H-type EH renal damage, aiming to provide new ideas for the prevention and treatment of H-type EH renal damage and to improve prognosis.

Materials and Methods

General information

From January to December 2025, 204 patients with H-type EH-related renal damage admitted to our hospital were included in the renal damage group, and 102 patients with H-type EH without renal damage were included in the EH group.

Inclusion criteria: (1) met the diagnostic criteria for H-type hypertension: systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, and β2-MG≥10 μmol/L. (2) Patients in the renal damage group were diagnosed with renal damage. ① Abnormalities in blood and urine components, or abnormal imaging findings or pathological findings persisted for 3 months. ② An estimated glomerular filtration rate (eGRF)<60 mL/(min·1.73 m^2) persisted for 3 months, and/or the MAU/UA ratio was >30 mg/g. Patients meeting any one of the above criteria can be diagnosed with renal damage. (3) Age >40 years. (4) Patients who received no relevant treatment before enrolment. (5) Complete clinical data of the patients.

Exclusion criteria: (1) had preexisting primary kidney disease before admission; (2) had secondary hypertension; (3) had secondary kidney disease caused by other diseases, such as diabetes; (4) had concurrent malignant tumours; (5) had taken nephrotoxic drugs within the last month; and (6) had concurrent local or systemic infections.

Collection of urine, MAU, and UA levels

Fresh midstream urine samples of 10 mL were collected within 24 hours after patient admission. The samples were subsequently centrifuged at 3,000 r/min for 10 minutes (with a centrifugal radius of 10 cm). The supernatant was then collected and analysed using a Swiss Roche Codelix Bio HT biochemical analyser (immunoturbidimetric method) to detect urine MAU and UA levels, and the MAU/UA ratio was calculated. The reagents were all purchased from Shanghai Yude Biotechnology Co., Ltd. (MAU lot number: YDLC-15171; UA lot number: YDLC-11696).

Urine β2-MG level detection

Within 24 hours of admission, 10 millilitres of venous blood was collected in the early morning and centrifuged at 3000 revolutions per minute for 10 minutes (with a centrifugal radius of 10 centimetres). Then, the supernatant was taken. Urine β2-MG levels were measured using the EnVision multi-functional microplate reader from the British company Revity, and the test was performed by enzyme-linked immunosorbent assay. The reagents and kits used were purchased from Nanjing Stebega Biotechnology Co., Ltd. (item number: SBJ-H0135). To ensure the accuracy and reliability of the test results, all samples were processed according to the reagent kit instructions, and negative and positive controls were used as quality controls. During testing, the laboratory temperature was maintained at 20–25 °C, and the humidity was kept at 50%–70% to minimise the influence of environmental factors on the experimental results. Each batch of specimens was tested in two wells, and the average value was used as the final result to improve test repeatability and stability.

The enzyme-linked immunosorbent assay method used in this study has high sensitivity and specificity. It accurately reflects the true level of β2-MG in the patient's urine, providing a reliable laboratory basis for diagnosing and assessing the risk of hypertension-induced renal injury.

Baseline data collection

Baseline data of patients were collected through the hospital's electronic medical record system, including sex, age, body mass index (BMI), disease duration, hypertension classification, underlying diseases (diabetes mellitus, hyperlipidaemia, and coronary heart disease), smoking history, drinking history, fasting blood glucose (FBG) at admission, total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), blood urea nitrogen (BUN), and urine uric acid (UA) levels.

Prognostic risk stratification assessment and grouping

Prognostic risk stratification was based on eGRF and MAU levels at admission in patients with EH renal impairment (see *Table I*). Patients with low- or intermediate-risk EH renal impairment were included in the low-intermediate-risk group, whereas patients with high- or very high-risk EH renal impairment were included in the high-risk group.

Table I Prognostic risk stratification assessment.

Prognostic risk stratification	eGRF [mL/(min ·1.73m^2)]	MAU grading (mg/g)
Low risk	≥60	<30
Medium risk	≥60	30~300
	45~<60	<30
High risk/ extremely high risk	≥60	>2000
	45~<60	>300
	<45	unlimited

Statistical analysis

Data processing and analysis were conducted using SPSS 26.0. Data that followed a normal distribution are expressed as $\bar{x}\pm s$, and comparisons between two groups were performed via the independent sample t-test. Count data are expressed as n (%), and comparisons between two groups were conducted via the χ^2 test. Rank data were compared using the rank-sum test. Multivariate logistic regression analysis was used to investigate the factors influencing renal damage in patients with H-type EH. A receiver operating characteristic (ROC) curve was drawn to analyse the predictive value of the urine β2-MG concentration and the ratio of the urine MAU/UA ratio for the prognostic risk stratification of renal damage in H-type EH patients, and an area under the curve (AUC) comparison was performed via the DeLong test. The significance level was $\alpha=0.05$ for all two-sided tests, and a difference was considered statistically significant if $P<0.05$.

Results

Comparison of baseline data between the EH group and the renal damage group

There were no statistically significant differences in sex, age, BMI, disease duration, hypertension grade, proportion of combined hyperlipidaemic patients, proportion of patients with combined

Table II Comparison of baseline data between EH group and renal impairment group [n (%) or $\bar{x}\pm s$].

Item	EH group (n=102)	Kidney damage group (n=204)	x^2/t/Z	P
Gender				
Male	62 (60.78)	132 (64.71)	0.228	0.638
Female	40 (39.22)	72 (35.29)		
Age (years)	55.89±6.98	56.40±7.27	-0.491	0.612
BMI (kg/m^2)	23.76±1.79	22.99±1.52	0.491	0.612
Disease duration (years)	6.75±1.60	6.94±1.86	-0.626	0.537
Hypertension classification				
Level I	40 (39.22)	60 (29.41)	1.072	0.284
Level II	34 (33.33)	78 (38.24)		
Grade III	28 (27.45)	66 (32.35)		
Underlying disease				
Combined diabetes	20 (19.61)	76 (37.25)	4.911	0.020
Combined hyperlipidaemia	28 (27.45)	62 (30.39)	0.145	0.700
Combined coronary heart disease	20 (19.61)	52 (25.49)	0.657	0.412
History of smoking	30 (29.41)	68 (33.33)	0.243	0.627
Have a history of drinking alcohol	34 (33.33)	78 (38.24)	0.355	0.556
FBG (mmol/L)	5.57±0.57	5.74±0.67	-1.621	0.109
TC (mmo/L)	5.15±0.98	5.36±0.80	-1.368	0.177
TG (mmo/L)	1.39±0.22	1.44±0.34	-0.964	0.331
HDL-C (mmo/L)	1.18±0.20	1.10±0.28	-0.457	0.653
LDL-C (mmoL/L)	3.02±0.72	3.23±0.87	-0.772	0.430
BUN (mg/L)	4.72±1.08	4.89±1.12	-0.359	0.725
UA (μmol/L)	69.42±9.28	72.19±11.10	-1.476	0.146

Table III Comparison of urine β2-MG levels and urinary MAU/UA ratio between EH group and renal injury group ($\bar{x}\pm s$).

Group	n	Urine β2-MG (mg/L)	Urine MAU/UA ratio
EH group	102	0.36±0.01	20.82±3.52
Kidney damage group	204	0.59±0.25	27.76±5.24
t		-10.258	-8.426
P		<0.001	<0.001

Table IV Multivariate logistic regression analysis of factors influencing renal damage in H-Type EH patients.

Factor	β	SE	Wald X^2	p	OR	% CI
Constant term	-0.097	0.054	3.390	<0.001	-	-
Combined diabetes	0.811	0.442	3.312	<0.001	2.269	0.943~5.466
Urine β2-MG	0.462	0.151	6.226	<0.001	1.591	1.109~2.314
Urine MAU/UA ratio	0.608	0.230	6.519	<0.001	1.834	1.154~2.917

coronary heart disease, proportion of patients with a history of alcohol consumption, FBG, TC, TG, HDL-C, LDL-C, BUN, or UA levels between the EH group and the renal damage group (P>0.05); the proportion of patients with diabetes in the renal damage group was greater than that in the EH group. The difference was statistically significant (P<0.05), see *Table II*.

Comparison of urine b2-MG levels and urine MAU/UA ratios between the EH group and the renal damage group

The urine β2-MG levels and urine MAU/UA ratios in the renal damage group were significantly higher than those in the EH group (P<0.05; see *Table III*).

Urine β2-microglobulin (β2-MG) levels and the uric acid/uric acid (MAU/UA) ratio in patients with H-type hypertension and renal injury showed significant increases. This finding indicates that the urine β2-MG concentration and the urine MAU/UA ratio may play an important role in the occurrence and development of renal injury in H-type hypertension. The high β2-MG state in patients with renal injury may reflect endothelial dysfunction and increased oxidative stress, while the increase in the urine MAU/UA ratio directly indicates damage to the glomerular filtration barrier. The abnormal changes in these two indicators jointly constitute important biological markers of renal injury in H-type hypertension, providing an objective basis for the early identification and intervention of hypertension-related renal injury in clinical practice.

Multivariate logistic regression analysis of the influencing factors of renal damage in patients with H-type EH

The occurrence of renal damage in patients with H-type EH was set as the dependent variable (occurrence =1, no occurrence =0), and the presence or absence of diabetes (present =1, absent =0), urine β2-MG (measured value), and the urine MAU/UA ratio (measured value) were used as independent variables to be included in the multivariate logistic regression model. The analysis revealed that elevated urine β2-MG levels and increased urine MAU/UA ratios were independent risk factors for renal damage in patients with H-type EH (P<0.05; see *Table IV*).

Comparison of urine b2-MG levels and urine MAU/UA ratios in patients with different prognostic risk stratifications of EH renal damage

The results of the prognostic risk stratification assessment revealed that there were 122 patients in the low- to moderate-risk group and 82 patients in the high-risk group; the urine β2-MG levels and urine MAU/UA ratios in the high-risk group were significantly greater than those in the low- to moderate-risk group (P<0.05), see *Table V*. The urine β2-MG concentration and the urine MAU/UA ratio are closely related to the prognosis risk stratification of patients with H-type hypertension-induced renal injury.

Table V Comparison of urine b2-MG levels and urinary MAU/UA ratio in EH renal injury patients with different prognostic risk stratification ($\bar{x}\pm s$).

Group	n	Urine b2-MG (mg/L)	Urine MAU/UA ratio
Low to medium risk group	122	0.31±0.06	26.57±4.86
High-risk group	82	0.65±0.31	29.53±5.39
t		-3.541	-2.906
P		0.001	0.002

Table VI The predictive value of urine β2-MG and urine MAU/UA ratio for high-risk prognostic levels in H-type EH patients with renal impairment.

Indicator	Best Truncation Value	Sensitivity (%)	Specificity (%)	AUC	AUC 95%CI	Youden index	P
Urine β2-MG	0.65 mg/L	75.64	80.36	0.781	0.699~0.866	0.552	<0.05
Urine MAU/UA ratio	27.79	78.08	70.42	0.786	0.694~0.852	0.488	<0.05
The combination of the two	-	73.10	95.01	0.860	0.788~0.929	0.686	<0.05

Predictive value of the urine β2-MG concentration and the urine MAU/UA ratio for the prognostic risk stratification of patients with H-type EH renal damage

With prognostic risk stratification of patients with H-type EH renal damage as the state variable (high-risk group = 1, low-moderate-risk group = 0) and urine β2-MG level and urine MAU/UA ratio as the test variables, a receiver operating characteristic (ROC) curve was drawn. The analysis revealed that the AUCs for urine β2-MG concentration, the urine MAU/UA ratio alone, and their combination for predicting high-risk patient prognosis in patients with H-type EH renal damage was 0.781, 0.786, and 0.860, respectively. The AUC of the combination was significantly greater than that of the individual predictions ($Z=2.035$, 1.953; both $P<0.05$), as shown in *Table VI*.

Discussion

Renal damage is a common complication of H-type EH. Because the patient's body remains in a »high-pressure« environment for a long time, angiotensin II increases the activity of oxidases on the cell membranes of vascular smooth muscle cells, releasing a large amount of reactive oxygen species, which affects the metabolism of the extracellular matrix. Reactive oxygen species not only increase vascular endothelial permeability but also promote lipid oxidation and, through the oxidative stress response, lead to vascular remodelling, damaging the normal functions of renal tubules and glomeruli and triggering renal damage (12–14). Previous studies have shown that urine β2-MG concentration and the urine MAU/UA ratio have diagnostic value for hypertension-induced renal damage (15–16). Still, the combination of the two parameters for effective diagnosis of renal damage in H-type EH patients and for prognostic risk stratification is relatively rare. This study analyses this phenomenon, which is beneficial for the prevention and treatment of renal damage in H-type EH.

This study analysed the urine β2-MG levels and the urine MAU/UA ratios in patients with type H EH with and without renal damage. The results revealed that urine β2-MG concentration and the urine MAU/UA ratio in the renal damage group were higher than those in the EH group. Possible reasons for this include the following: urine β2-MG is an intermediate metabolite of methionine. Under normal circumstances, during kidney clearance, the peripheral circulation β2-MG level is relatively low. When renal function is impaired, urine β2-MG cannot be cleared promptly, leading to elevated urine β2-MG levels.

Therefore, the urine β2-MG level in patients with renal damage is greater than that in patients with type H EH without renal damage (17–18). The urine MAU/UA ratio is an important indicator of MAU excretion by the patient's kidneys. This indicator usually increases in the early stage of renal damage (19). In this study, the increase in the urine MAU/UA ratio in patients with renal damage may reflect the progressive loss of renal microvessels. Hypertension-induced renal arteriolar lesions accumulate in the renal vessels, damaging the glomerular filtration membrane and impairing glomerular filtration. MAU cannot be reabsorbed by the filtra-

tion function of the glomerulus, thereby causing an increase in the level of MAU in urine (20). UA is excreted through glomerular filtration, and when the glomerulus is slightly damaged, the excretion of UA is essentially stable. Therefore, the urine MAU/UA ratio in patients with renal damage is significantly increased in the early stage of renal damage (21). Owing to the influence of various factors, such as exercise and urinary tract infections, on MAU and the simultaneous influence of UA on the glomerulus, the urine MAU/UA ratio can more accurately reflect damage to the body's renal function and avoid the one-sidedness of a single indicator. Therefore, the urine MAU/UA ratio has greater clinical value for early renal damage (22).

This study analysed the urine β2-MG levels and urine MAU/UA ratios of patients with different prognostic risk stratifications. Urine β2-MG levels and urine MAU/UA ratios in the high-risk group were significantly higher than in the low- to moderate-risk group, suggesting that these markers are associated with prognostic risk stratification in patients with H-type EH renal damage. The reasons for this are as follows: urine β2-MG can activate the renin-angiotensin system, leading to increased glomerular intraparenchymal pressure and exacerbating proteinuria and glomerular damage (23). Moreover, the continuous increase in urine β2-MG levels can further intensify oxidative stress and inflammatory responses, further damaging vascular endothelial function, inducing the generation of many free radicals, damaging the renal microcirculation, and further aggravating renal damage, shifting the prognostic risk stratification of patients upward. Moreover, loss of vascular endothelial function promotes atherosclerosis and microthrombus formation, accelerating glomerular sclerosis and affecting the prognosis of patients with H-type EH renal damage (24–25). An increase in the urine MAU/UA ratio indicates the loss of charge selectivity of the glomerular filtration membrane, allowing albumin to leak into the urine. The leaked albumin can further exacerbate the inflammatory response in renal tubules and the interstitium, promote collagen deposition, and ultimately lead to renal interstitial fibrosis (26). To further explore the predictive value of urine β2-MG concentration and the urine MAU/UA ratio for prognostic risk stratification of patients with H-type EH renal damage, a ROC curve was generated for in-depth analysis. The results revealed that the AUC of the combined prediction of the urine β2-MG concentration and the urine MAU/UA ratio for the high-risk prognosis of H-type EH renal damage patients was 0.867, which was greater than the AUC of each prediction alone, suggesting that the combined prediction efficacy of the urine β2-MG concentration and the urine MAU/UA ratio is greater than that of individual detection (27). Since the urine β2-MG concentration and the urine MAU/UA ratio can be used to assess a patient's renal function through both blood and urine, the use of a single indicator in the diagnosis of H-type EH renal damage is limited. Therefore, the combined prediction value is higher. The higher the urine β2-MG level and urine MAU/UA ratio are, the greater the prognostic risk stratification of patients with H-type EH renal damage and the worse the prognosis.

Conclusion

Urine β2-MG levels and the urine MAU/UA ratio are increased in patients with H-type EH renal damage. Moreover, elevated urine β2-MG levels and the urine MAU/UA ratio are independent risk factors for renal damage in H-type EH patients. The combination of these two factors has a high predictive value for the high-risk prognosis of H-type EH patients with renal damage.

Authors' contributions

Chezhao Huang is the first author, and Yanshuang Zhuang is the co–first author.

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Ethical approval

This study was approved by the hospital's medical ethics committee (approval numbers: AF/SC-08/06.1 and AF/SC-07/06.2). All patients signed the informed consent form.

Conflict of interest statement

All the authors declare that they have no conflict of interest in this work.

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