

Age-Related Changes in Renal Resistive Index After ESWL

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Submission date: 18-Nov-2019 12:27PM (UTC+0800)

Submission ID: 1215948534

File name: Anton.pdf (7.15M)

Word count: 55

Character count: 155

AGE-RELATED CHANGES IN RENAL RESISTIVE INDEX AFTER ESWL

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ABSTRACT

Objective: To determine relation between age and resistive index (RI) changes occurring after extracorporeal shock wave lithotripsy (ESWL). **Material & Method:** We performed a prospective study in Soetomo Hospital Surabaya. Using duplex ultrasonography, RI was determined in 20 patients with calyceal kidney calculi and pelvic kidney calculi. RI of the interlobar renal arteries were measured in the region near the calculi (distance, less than 2 cm), one hour before ESWL and RI was measured again at 1 hour, 3 days and 7 days after ESWL. Changes in RI values and relation with age (≤ 60 years old and > 60 years old) were evaluated. **Results:** The renal RI increased significantly 1 hour and 3 days after ESWL, but returned to before ESWL values 7 days after ESWL in the both groups. Although there was positive correlation between age and RI before ESWL, but there was no correlation between age and RI changes after ESWL. **Conclusion:** Renal RI is higher with age > 60 years, after ESWL renal RI showed transient increase which returned to baseline after 7 days.

Key words: Color Doppler Ultrasonography, extracorporeal shock wave lithotripsy, renal resistive index, calyceal kidney calculi, pelvic kidney calculi.

ABSTRAK

Tujuan: Melihat pengaruh usia terhadap perubahan nilai resistive index (RI) ginjal, yang terjadi setelah tindakan extracorporeal shock wave lithotripsy (ESWL). **Bahan & Cara:** Kami melakukan penelitian prospektif di RSU Dr. Soetomo Surabaya. Nilai RI ginjal diukur dengan menggunakan ultrasonografi dupleks pada 20 pasien dengan batu kaliks dan batu pelvis ginjal. Dilakukan pengukuran nilai RI pada arteri interlobar ginjal dekat batu (jarak kurang dari 2 cm dari posisi batu), 1 jam sebelum ESWL dibandingkan dengan 1 jam, 3 hari dan 7 hari setelah ESWL. Lalu dievaluasi pengaruh usia (≤ 60 tahun dan > 60 tahun) terhadap perubahan nilai RI ginjal tersebut. **Hasil:** Nilai RI ginjal pada kedua kelompok meningkat secara bermakna 1 jam dan 3 hari setelah ESWL, kemudian kembali ke nilai seperti sebelum ESWL 7 hari kemudian. Pada penelitian ini didapatkan, kelompok usia > 60 tahun mempunyai nilai RI yang lebih tinggi daripada kelompok usia ≤ 60 tahun, dengan nilai $p < 0.0001$. Tidak didapatkan adanya pengaruh usia terhadap perubahan nilai RI ginjal setelah ESWL antara dua kelompok usia tersebut. **Simpulan:** Indeks resistif ginjal lebih tinggi pada usia > 60 tahun, dan RI meningkat sepintas setelah ESWL dan kembali ke nilai semula setelah 7 hari.

Kata Kunci: Duplex ultrasonografi, extracorporeal shock wave lithotripsy, resistive index ginjal, batu kalik, batu pelvis ginjal.

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INTRODUCTION

After the discovery of extracorporeal shock wave lithotripsy (ESWL) and endourology technology, over the last decade, a dramatic change

has taken place in the management of urinary tract stones. Today, ESWL is the treatment of choice for calyx or renal pelvis stones less than 2 cm in diameter, except contra indicated.¹ American Urological Association (AUA) in its guidelines has

directed that ureteric and kidney stones with size less than 2 cm is managed with ESWL therapy.² European Association of Urology in 2011 also created the guidelines of treatment with ESWL therapy. ESWL is used as first-line therapy in kidney stones with a diameter less than 2 cm.³

Stone-free rate in the treatment of kidney stones using ESWL machine in adult patients is more than 90%, except in lower calyx stone the stone-free rate is around 25-85%.³ ESWL is preferred because it is non-invasive and the resulting morbidity is relatively low compared to open surgery or other more invasive techniques.⁴ However, large, multiple, and hard stones need several ESWL sessions. Surgery is required when there are complications, such as obstruction due to debris.⁴

Safety of ESWL is debatable because the energy produced by ESWL also has the ability to damage the kidney tissue.⁵ Although non-invasive and safe, ESWL can also lead to complications, such as subcapsular, perirenal hematoma, bruises or renal parenchymal contusion.^{6,7} Using magnetic resonance imaging (MRI) to the kidney tissue after ESWL, edema, hematoma and contusions are structurally apparent as in renal trauma.^{7,8} Functionally, ESWL potentially causes or aggravates kidney failure.⁹ This can be caused by vasoconstriction and decreased blood flow to the kidneys. These complications can be monitored by resistive index (RI) examination in intrarenal arteries using duplex ultrasound.¹⁰ Up to the moment, impact of ESWL on renal RI in Soetomo Hospital, even in Indonesia, has not been studied. The purpose of this study was to analyze the effect of ESWL on renal parenchyma using RI.

OBJECTIVE

To determine relation between age and RI changes occurring after ESWL.

MATERIALS & METHODS

From June to September 2012 patients diagnosed with kidney stones that were about to undergo ESWL in Dr. Soetomo Hospital were included in this study. They were divided into 2 groups: group 1 (age group less than or equal to 60 years), and group 2 (age group over 60 years). Inclusion criteria included patients diagnosed with calyx kidney stones or pyelum stones sized > 0.6 cm and < 2 cm; single stone; creatinine serum less than 1.5 mg/dL; routine blood tests; normal hemostatic

and electrolyte physiology; IVP examination; aged over 18 years, and willing to follow and sign the informed consent. Exclusion criteria included history of previous renal failure; previous history of diabetes mellitus; pregnancy; physiology of hemostasis disorders; and obesity (BMI > 27). Patients dropped out of the study if after ESWL there were signs of infection, obstruction or the patient did not come to scheduled examination.

Patients with calyx or pyelum stone or stones which had been demonstrated by clinical examination either by history taking or urological radiological ultrasonography (USG) and the intravenous pyelography (IVP), and meeting the inclusion and exclusion criteria, were divided by age, and subsequently measured for RI value in kidneys to be subjected to ESWL using Logiq5 Expert ultrasound on the interlobar renal artery within 2 cm of the stone. An hour later, ESWL was performed with HK V ESWL machine, with frequency of 1 Hz and the power started from 8 KV and increased 1 KV every 250 shocks. At end of the procedure there would be 3000 to 3500 shocks. An hour later RI values were measured in renal interlobar artery within 2 cm of the stone using ultrasound equipment GE Logiq5 Expert. Renal RI was re-examined in interlobar artery within 2 cm of the stone by using the same tool, site, and operator on day 3 and day 7 after the ESWL procedure. Based on the results of duplex ultrasound examination, the data obtained were processed statistically.

The analysis was carried out descriptively or analytically. Comparative test was carried out on RI value of both sample groups using independent samples t-test. Comparative test of RI values between observations was done with paired t-test. If the significance was less than 0.05 ($p < 0.05$), then there was difference between the values before and after ESWL, as well as between patients aged less than or equal to 60 years and more than 60 years of age. Significance level was < 0.05.

RESULTS

From June to September 2012, there were 32 patients who underwent ESWL in urology minimally invasive installation (IIU), at request of the urology clinic physician at Dr. Soetomo Hospital, Surabaya. Twenty patients who met inclusion and exclusion criteria were included in the study and grouped by age. Ten patients in group aged less than or equal to 60 years, and other 10 patients were

included in age group over 60 years. All patients underwent renal resistive index examination before ESWL, and re-examination of renal resistive index was also done 1 hours, 3 days and 7 days after ESWL by the same operator. Two patients of the age group over 60 years dropped out because absence of post ESWL duplex ultrasound examination.

The mean value of renal RI before ESWL in age group of less than or equal to 60 years was 0.59, with the lowest value 0.52 and the highest 0.70. The mean value of renal RI before ESWL in age group over 60 years was 0.70, with the lowest value 0.68 and the highest value 0.74 (Table 1).

Table 1. Description of renal RI before ESWL.

Description	≤ 60 years n = 10	> 60 years n = 8	p
Mean	0.59	0.70	< 0.0001
Standard deviation	0.06	0.02	
Minimum Value	0.52	0.68	
Maximum Value	0.70	0.74	

Renal RI prior to ESWL in two study groups showed statistically significant differences, but the pattern of the curve in both groups showed the same pattern, the value of renal RI in both groups increased 1 hour after ESWL, and started to decrease at 3 days after ESWL, then returned to baseline on day 7 after ESWL.

Table 2 showed results of statistical tests with paired t-test on the value of renal RI before ESWL and renal RI 1 hour, 3 days and 7 days after ESWL in age group of less than or equal to 60 years. Renal RI 1 hour after ESWL and 3 days after ESWL showed statistically significant increase (0.623 ± 0.056 with $p = 0.002$ and 0.603 ± 0.050 with $p = 0.032$), while the value of renal RI 7 days after ESWL showed no statistically significant difference from renal RI prior to ESWL (0.590 ± 0.056 with $p = 0.193$). Table 3 shows the results of statistical tests with paired t-test of the value of renal RI before ESWL 1 hour, 3 days and 7 days after ESWL in the age group over 60 years. Renal RI value of 1 hour and 3 days after ESWL.

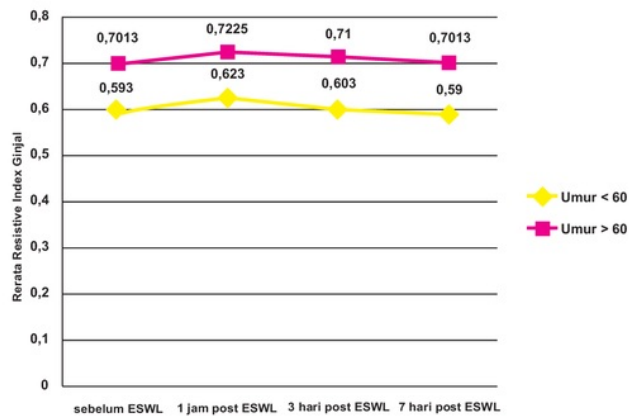


Figure 1. Comparison of renal RI before ESWL and 1 hour, 3 days and 7 days after ESWL.

Table 2. Changes in renal RI before ESWL and 1 hour, 3 days, and 7 days after ESWL in age group ≤ 60 years.

Observation Time	RI	Delta	p
Before ESWL	0.593 ± 0.056	-	-
1 hour after ESWL	0.623 ± 0.056	0.030 ± 0.023	0.002
3 days after ESWL	0.603 ± 0.050	0.010 ± 0.012	0.032
7 days after ESWL	0.590 ± 0.056	-0.003 ± 0.007	0.193

Table 3. Changes in the value of renal RI before ESWL and 1 hour, 3 days, and 7 days after ESWL in age group over 60 years.

Observation Time	RI	Delta	p
Before ESWL	0.701 ± 0.020	-	-
1 hour after ESWL	0.723 ± 0.024	0.021 ± 0.089	< 0.0001
3 days after ESWL	0.710 ± 0.021	0.009 ± 0.008	0.021
7 days after ESWL	0.701 ± 0.023	0.000 ± 0.005	1.000

Table 4. Differences in variance changes of renal RI 1 hour, 3 days, and 7 days after ESWL.

RI changes with that before ESWL	≤ 60 Years	> 60 Years	p
1 hour after ESWL	0.030 ± 0.022	0.021 ± 0.008	0.280
3 days after ESWL	0.010 ± 0.012	0.009 ± 0.008	0.803
7 days after ESWL	- 0.030 ± 0.001	0.000 ± 0.005	0.308

After ESWL there was a statistically significant increase (0.723 ± 0.024 with p < 0.0001 and 0.710 ± 0.021 with p = 0.021), while the value of renal RI 7 days after ESWL showed no statistically significant difference from the value of renal RI before ESWL (0.701 ± 0.023 with p = 1.000). The mean value of renal RI 1 hours, 3 days and 7 days after ESWL showed no significant difference in both groups with p = 0.280, p = 0.803, and p = 0.308 (Table 4).

DISCUSSION

Renal RI in normal individuals showed significant differences depending on age and sampling. Clinically, values below 0.7 is regarded as normal, and values above 0.7 are declared pathological.¹¹ In general, it has been recognized that in patients with age entering the seventh decade, the value of normal renal RI could be more than 0.7. This is probably caused by the reduced elasticity of the tissue and renal vasculature.¹² Bude et al. showed that renal RI depends on the elasticity of blood vessels and the resistance of renal vasculature. Renal RI will increase in patients with decreased blood vessel elasticity, although there are no obstruction within the blood vessel itself.¹³ Renal tubular interstitial tissue damage is closely related to impaired kidney function and determines the prognosis.¹⁴

In this study, the mean value of renal RI obtained before ESWL in patients aged less than or equal to 60 years of age was 0.59 ± 0.06, while the lowest value of renal RI was 0.52 ± 0.06. The highest value of renal RI was 0.70 ± 0.06. Whereas in group

of patients aged over 60 years the mean renal RI was 0.70 ± 0.02, with the lowest value of renal RI of 0.68 ± 0.02 and the highest value of renal RI was 0.74 ± 0.02.

In this study there was statistically significant difference between renal RI before ESWL in the group of patients aged less than or equal to 60 years, with the group of patients aged over 60 years, with p < 0.0001. Renal RI which was obtained by using duplex ultrasound examination, describes the presence of obstacles in renal arteries, indirectly shows the flow of renal vasculature.¹⁵ Based on research by Aoki et al., renal RI is increased after ESWL due to inflammation and edema surrounding renal artery and its branches. Perivascular tissue thickening eventually increase vascular resistance.¹⁶

Ellah MA et al. investigated arterial spin labeling (ASL), magnetic resonance (MR), magnetic resonance imaging (MRI) with contrast and measured the value of renal RI 12 hours before ESWL and 12 hours after ESWL. Renal RI values was significantly increased 12 hours after ESWL (p < 0.001).⁵

Mohseni MG et al. showed that value of the renal RI in interlobar arteries with a distance of less than 2 cm of the stone increased significantly 30 minutes after ESWL (p = 0.003), and returned to baseline one week later.¹⁰ This study also showed a significant increase in the value of renal RI 1 hour after ESWL in the age group of less than or equal to 60 years, with p value = 0.002, and in the age group over 60 years with p value = 0.032, compared to renal RI value prior to ESWL.

Hiros et al. showed that kidneys subjected to ESWL had significant increase in renal RI on the first

day and the third day after ESWL, with $p < 0.001$ and $p = 0.007$, while the value of renal RI in seven days after ESWL increased significantly (0.62 ± 0.05).¹⁷

Similarly, this study also showed that in patients aged less than or equal to 60 years renal RI 3 days after ESWL had significant difference from baseline, with $p = 0.032$. This also occurred in group of patients aged over 60 years. There were significant differences in RI values between baseline and 3 days after ESWL, with $p = 0.021$.

Data in this study also showed that there was no significant difference in the value of renal RI before ESWL to 7 days after ESWL in group of patients aged less than or equal to 60 years, with p value = 0.193. This was also found in age group over 60 years who did not show any difference in renal RI before ESWL, with $p = 1.000$.

Knapp et al. found a linear correlation between age and changes in renal RI after ESWL. In general, it has been recognized that normal renal RI values in patients with age entering the seventh decade can be more than 0.7. This may be caused by the decrease in tissue and renal blood vessels elasticity.¹² Aoki et al. stated that patients aged over 60 years have a higher RI value. In their study, 8 of 31 (25.8 %) patients studied had a renal RI value of 0.7 or higher before ESWL.¹⁶

In contrast to the results of Knapp et al., Aoki et al. found that the increase in the value of renal RI in those over 60 years after ESWL was not affected by age but by many factors, such as time of examination, type of lithotripter used, energy of shocks, number of shocks, focusing ability, and renal function prior to ESWL.¹⁶

In contrast to the study by Knapp et al, in this study there was no significant correlation between age and changes in renal RI after ESWL, although there were significant differences in the value of renal RI in both groups of patients before ESWL, with $p < 0.0001$.

At 1 hour after ESWL no significant difference in renal RI between the two groups were observed ($p = 0.280$). This was also found in renal RI examination 3 days after ESWL, and there was also no significant difference between the two groups, with $p = 0.803$. Seven days after ESWL there was also no difference in renal RI between the two groups with $p = 0.308$.

Although the mean increase of renal RI in age group over 60 years was higher than that in age group of less than or equal to 60 years, the value of this difference was not statistically significant. This

suggests that higher increase in renal RI after ESWL in age group above 60 years was because their threshold of renal RI was higher than that in age group of less than or equal to 60 years, not influenced by age.

CONCLUSION

There is a significant correlation between age and the value of before ESWL renal RI in age group over 60 years, the value of renal RI is higher in age group of less than or equal to 60 years, but there is no significant correlation between age and the change in renal RI after ESWL.

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