



RESEARCH ARTICLE

Correlation of Sacral Ratio and Urinary Tract Infection in Children

Fahimeh Ehsanipour¹, Zahra Movahedi², Leila Taherinia³ and Samileh Noorbakhsh^{1,*}

¹Department of Pediatric Infectious Diseases, Iran University of Medical Sciences, Tehran, Iran

²Department of Pediatric Infectious Diseases, Qom University of Medical Sciences and Health Services, Qom, Iran

³Tehran University of Medical Sciences, Tehran, Iran

Received: June 3, 2018

Revised: August 11, 2018

Accepted: August 15, 2018

Abstract:

Introduction:

The sacral bone anomalies have an important effect on urinary and gastrointestinal tract and sacral ratio was defined as an indicator for estimating the anorectal abnormalities in children. This study was carried out for determining the association between sacral ratio and Urinary Tract Infections (UTI) among children.

Material and Methods:

In a cross sectional study, 100 children under 15 years with proven febrile UTI were referred to a referral children center considering the presence and grading of VUR according to VCUG enrolled in this study.

Sacral ratio was measured for all cases and the data were compared by student T test, Chi 2 and Mann Whitney tests. SPSS 16.0 software was used for data analysis. P values less than 0.05 were considered significant.

Results:

41 boys and 59 girls with mean age 4.8 years were enrolled in this study. The average range of sacral ratio was 0.82. There was no statistical difference between two different genders and ages ($p > 0.05$).

The values of SR in patients with VUR were lower than patients without VUR ($P < 0.05$) but there was no statistically significant difference between both bilateral and unilateral VUR and SR ($p > 0.05$).

Conclusion:

The risk of sacral bone abnormality in patients with VUR is more than patients without VUR. Therefore, in patients with UTI and low SR simultaneously, tighter evaluation for VUR and treatment should be considered.

Keywords: Sacral Ratio, UTI, VUR, Children, Bone abnormality, Urinary Tract Infections.

1. INTRODUCTION

Urinary Tract Infections (UTI) are considered as the most common bacterial infections among children. The prevalence of UTI is estimated 2% in boys and 8% in girls [1, 2]. UTI can predispose the patients to increase the risk of renal failure due to renal scarring and hypertension and end stage renal disease in pediatric population. Sacral bone abnormality like hypoplasia or agenesis is one of the important risk factors for urinary dysfunction [2]. Recurrent UTI is defined as a further infection by a new organism. Relapsing UTI is defined as a further infection with the same organism. The recurrent infections can result in renal scarring, which can lead to renal hypertension and end-stage renal disease [3]. Although using new diagnostic tests and appropriate treatment, the mortality and morbidity of UTI are

* Address correspondence to this author at the Department of Pediatric Infectious Diseases, Iran University of Medical Sciences, Tehran, Iran, Tel: 098-21-66525328, E-mail: samileh_noorbakhsh@yahoo.com

diminished significantly, but UTI is an important factor producing structural dysfunction, progressive renal failure, hypertension and also renal stones [2]. Although the complication does not occur in most patients after treatment, but also identifying the susceptible patients is very important for the prevention of complication [3, 4]. Acute pyelonephritis and VUR are diagnosed as two synergistic factors producing the destruction in pediatric kidneys [4]. Vesicoureteral Reflux (VUR) is an important urological abnormality which can cause recurrent febrile UTI in childhood. Obstructive anomalies are found in up to 4%, and VUR in 8% to 40% of children being investigated for their first UTI. The recurrent UTI can be complicated by renal scarring, which can lead to renal hypertension and end-stage renal disease [5]. Many authors consider the Long-term antibiotics for preventing recurrent urinary tract infection in pediatric population [6, 7]. In some investigations antibiotics of choice for preventing gram negative microorganisms are suggested by authors [8, 9], although Ian *et al.* showed early treatment of acute pyelonephritis in children fails to reduce renal scarring [10]. In purpose to detect urinary tract anomalies, VCUG (voiding cystourethrogram) is the most useful methods in children ([11, 12] The potential role for MRU (Magnetic Resonance Urogram) in the diagnostic work-up of upper urinary tract dilatation in infants and children is showed by some authors [13, 14]. Diagnostic strategies of interstitial cystitis due to infections were described by Patnaik [15]. Sacral bone abnormality like hypoplasia or agenesis is one of the important risk factors for urinary dysfunction [2].

The relationship between sacral agenesis and VUR, enuresis, voiding dysfunction, and neurogenic bladder is well known previously [16 - 20].

Pena *et al.* suggested the Sacral Ratio (SR) for evaluation of sacral development. Sacral ratio was calculated according to Pena criteria in plain lumbosacral spinal radiography [16]. Three lines were drawn for each pelvic radiograph, a line is drawn connecting the upper zone of both iliac crests, the second line was connecting the most inferior point of the sacroiliac joints and the third line parallel to other lines across the inferior points of the sacrum. By dividing the distance between the two baseline (on the distance between the two upper lines sacral ratio were calculated [16]. MC Lellan *et al.* reported the relationship between sacral anomalies and urinary dysfunction [17]. Sacral index is a marker which were used for identifying the predisposing risk factors for UTI, urinary dysfunction, VUR, constipation and also urinary incontinence [17]. Correlation between SR and anorectal anomalies were evaluated by Macedo *et al.* and others [18 - 20].

UTI is a common cause for hospital admission among Iranian children [21 - 24]. A prospective clinical study by some Iranian workers determined the incidence of renal scarring following acute pyelonephritis and previously well-known risk factors such as VUR, age and recurrent urinary tract infections [21]. Association of voiding dysfunction following sacral anomalies was considered in the previous Iranian studies [24, 25].

The aim of present study was determination of average SR among children with UTI admitted in pediatric ward of Rasul Akram Hospital during 2008-2016.

2. MATERIALS & METHODS

This cross sectional study were performed upon 100 children (< 15 years old) with proven febrile UTI who were admitted in pediatric department in Rasoul Akram Hospital, Tehran, Iran during 2008-2016.

The patients with structural sacrum anomaly included myelomeningocele and sacrococcygeal teratoma, imperforated anus, lipomeningocele and all children with history of trauma or pelvic fracture were excluded from the study.

Diagnostic criteria: UTI was diagnosed as positive urine culture with more than 10^5 colony-forming units per milliliter of a single pathogen or 10^4 colonies in a symptomatic patients or > 50000 colonies of a single pathogen in obtained samples via suprapubic or catheter [1].

VCUG was performed for all cases within 6 weeks after urinary tract infection. Sacral ratios were calculated according to Pena criteria in plain lumbosacral spinal radiography [16]. Three lines were drawn for each pelvic radiograph, a line is drawn connecting the upper zone of both iliac crests, the second line was connecting the most inferior point of the sacroiliac joints and the third line parallel to other lines across the inferior points of the sacrum. By dividing the distance between the two baseline (BC) on the distance between the two upper lines (AB), sacral ratio was calculated. The normal limits of SR were considered as ≥ 0.74 in anteroposterior and ≥ 0.77 in lateral view according to Pena *et al.* criteria [16].

All data were entered in the check list and finally were analyzed by SPSS 16.0 software.

3. RESULTS

One hundred children (mean age 4.8 years and SD of 3.2 years) were enrolled in the study. 41 (41%) of the total cases were male and 59 (59%) were female.

The patients were divided to 3 groups according to age. The average SR in patients between 2-5 years was 0.80 with 0.079 SD and for cases between 5-10 years and 10-15 years was 0.84 (SD : 0.076) and 0.83 (SD : 0.07) respectively (Fig. 1). The average SR in girls was 0.81 with 0.076 SD and in boys was 0.85 with 0.08 SD. There was no significant difference between SR and age and gender ($p > 0.05$).

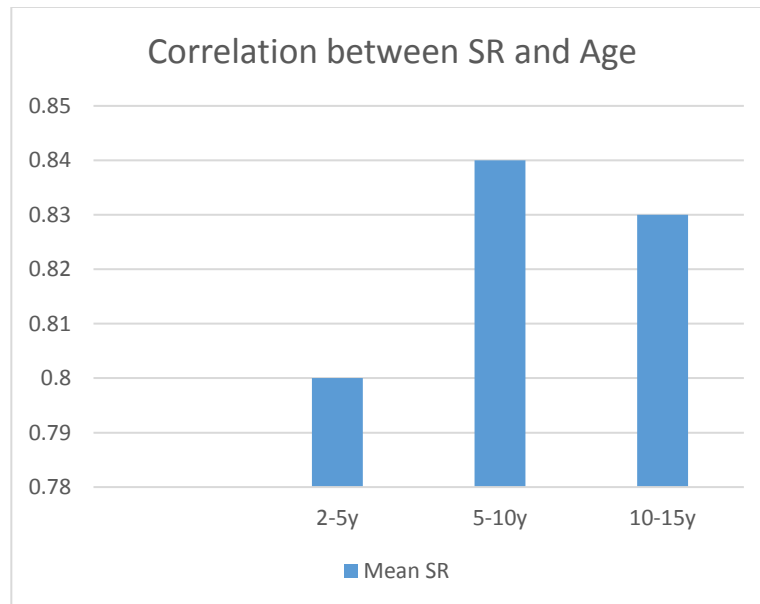


Fig. (1). Correlation between SR and age.

The cases were divided into four groups according to the existence of VUR and also VUR grading. The SR scales in relation to VUR and grading were compared which are shown in Table 1.

Table 1. SR scale in relation to VUR and grading.

VUR	Mean	Minimum	Maximum
Grade 1	0.85	0.63	0.90
Grade 2	0.82	0.64	0.92
Grade 3	0.80	0.70	0.95
Without VUR	0.87	0.62	0.94

There was no significant difference among the patients with unilateral VUR and SR (average = 0.81 and SD 0.076) and also the patients with bilateral VUR and SR (average = 0.84 with SD 0.071 ($P > 0.05$)). But SRI decreases in parallel to increasing VUR grading. This index in patients without VUR has higher mean level in comparison to children with VUR.

4. DISCUSSION

In the present study we investigated the relation between SRI and VUR in children (< 15 years old) with proven UTI. According to our results no significant difference was observed between age and gender with SRI. No correlation between unilateral VUR and SRI (average = 0.81 and SD 0.076) and bilateral VUR and SR (average = 0.84 with SD 0.071) had found in our studied cases. SRI decreases in parallel to increasing VUR grading. This index in patients without VUR has higher mean level in comparison to children with VUR.

SRI (Sacral index) was a marker which were used for identifying the predisposing risk factors for UTI, urinary dysfunction, VUR, constipation and also urinary incontinence [16 - 18] and low SR index which represent the sacral bone development can in turn create urinary system disorders [16].

Kajbafzadeh *et al.* investigated the correlation of SR index and results of VUR among 30 children with UTI and controls. They found no significant difference between age and this index, compatible to our results [19]. Yousefichaijan *et al.* reported the sacral Index in children suffering from different grades of VUR [20].

According to the results of the present study, in parallel to increasing the VUR grading, the sacral index is diminished, but because existence of sacral bone anomalies was not considered, SR was used as an independent factor in relation to VUR and considering the chance of simultaneous occurrence of abnormal SR and VUR, in the absence of sacral anomaly due to close embryonic origin of sacral bone and bladder or neurogenic infrastructural abnormality in patients with abnormal SR and also insufficient sample size, other studies with higher sample size are needed. On the other hand, abnormal SR can be recognized as a risk factor for predicting UTI occurrence, therefore these cases can be evaluated for UTI occurrence from earlier ages.

CONCLUSION

The risk of sacral bone abnormality in patients with VUR is more than patients without VUR. According to the results of present study, SR decreases in parallel to increasing VUR grading. This index in patients without VUR has higher mean level in comparison to children with VUR.

Therefore, in patients with UTI and low SR simultaneously, tighter evaluation for VUR and treatment should be considered.

Considering relationship between SR and occurrence of VUR, correlation of this index with UTI, point of determination and also prediction of prognosis, the treatment programs can be planned meticulously.

LIMITATION OF THE STUDY

Our study included a relatively small sample size and lacked of long-term follow up.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical Committee in the Pediatric Infectious Diseases (affiliates by Iran University of Medical Sciences) has reviewed and approved the Waiver of Authorization for use of protected health information (PHI) for research purposes for the following study and the number is 92-01-131-25731.

HUMAN AND ANIMAL RIGHTS

Animals did not participate in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2008.

CONSENT FOR PUBLICATION

Consent for publication was obtained.

CONFLICTS OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The research team wish to thank vice chancellor of research for their financial support and also children and their parents who contribute to this research.

REFERENCES

- [1] Masson P, Matheson S, Webster AC, Craig JC. Meta-analyses in prevention and treatment of urinary tract infections. *Infect Dis Clin North Am* 2009; 23(2): 355-85.
[http://dx.doi.org/10.1016/j.idc.2009.01.001] [PMID: 19393914]
- [2] Tenke P. Urinary Tract Infections in Children, ISBN: 978-953-307-757-4, In Tech, Available from: <http://www.intechopen.com/books/urinary-tractinfections/uti-in-children>
- [3] González E, Papazyan JP, Girardin E. Impact of vesicoureteral reflux on the size of renal lesions after an episode of acute pyelonephritis. *J Urol* 2005; 173(2): 571-4.
[http://dx.doi.org/10.1097/01.ju.0000151263.36909.91] [PMID: 15643259]
- [4] Hoberman A, Charron M, et al. Imaging study after a first febrile UTI in young children. *N Engl J Med* 2003; 348: 195.
[http://dx.doi.org/10.1056/NEJMoa021698] [PMID: 12529459]
- [5] Lee YS, Han SW. Pediatric vesicoureteral reflux: Slow but steady steps. *Investig Clin Urol* 2017; 58(Suppl. 1): S1-3.
[http://dx.doi.org/10.4111/icu.2017.58.S1.S1] [PMID: 28612054]
- [6] Williams G, Craig JC. Long-term antibiotics for preventing recurrent urinary tract infection in children. *Cochrane Database Syst Rev* 2011; 3(3): CD001534.
[PMID: 21412872]
- [7] Noorbakhsh S, Lari AR, Masjedian F, Mostafavi H, Alaghebandan R. Comparison of intravenous aminoglycoside therapy with switch therapy to cefixime in urinary tract infections. *Saudi Med J* 2004; 25(10): 1513-5.
[PMID: 15494842]
- [8] Cheng C-H, Tsai MH, Huang YC, et al. Antibiotic resistance patterns of community-acquired urinary tract infections in children with vesicoureteral reflux receiving prophylactic antibiotic therapy. *Pediatrics* 2008; 122(6): 1212-7.
[http://dx.doi.org/10.1542/peds.2007-2926] [PMID: 19047236]
- [9] Noorbakhsh S, Farhadi M, Tabatabaei A. Determination of the MIC of antibiotics for gram negative microorganisms isolated from the sterile sites of children hospitalized in Rasool Akram hospital. *Iran J Pediatr* 2006; 16(4): 419-25.
- [10] Hewitt IK, Zucchetta P, Rigon L, et al. Early treatment of acute pyelonephritis in children fails to reduce renal scarring: Data from the Italian Renal Infection Study Trials. *Pediatrics* 2008; 122(3): 486-90.
[http://dx.doi.org/10.1542/peds.2007-2894] [PMID: 18762516]
- [11] Luk Hang. Yip Hin Woo drea Wai San Au-Yeung James Chi Sang Chan. Imaging in pediatric urinary Tract infection: A 9-year local experience. *wing an AJR*:192, may 2009
- [12] Ataei N, Sayari-Fard F, Madani A, Esfahani T, Khorasani M, et al. Scintigraphic screening in the detection of renal scarring in siblings of children with primary reflux. *Acta Med Iran* 2007; 45(3): 219-26.
- [13] Riccabona M. Pediatric MRU--its potential and its role in the diagnostic work-up of upper urinary tract dilatation in infants and children. *World J Urol* 2004; 22(2): 79-87.
[http://dx.doi.org/10.1007/s00345-004-0406-z] [PMID: 15197478]
- [14] Zarabi V, Noorbakhsh S, Rahim Zadeh N, Samimi K. Diagnostic value of dynamic Magnetic Resonance Urogram imaging in children with Urinary Tract Infection. *TUMJ* 2011; 69(2): 872-87.
- [15] Patnaik SS, Laganà AS, Vitale SG, et al. Etiology, pathophysiology and biomarkers of interstitial cystitis/painful bladder syndrome. *Arch Gynecol Obstet* 2017; 295(6): 1341-59.
[http://dx.doi.org/10.1007/s00404-017-4364-2] [PMID: 28391486]
- [16] Pena A. Anorectal malformations. *Seminars in pediatric surgery* 1995; 4(1): 35-47.
- [17] McLellan DL, Bauer SB. Bladder dysfunction. In: Avner ED, Harmon WE, and Niaudet P. *Pediatric Nephrology* 2004, 5th edition, Lippincott Williams and Wilkins Company, Philadelphia, P. 1078-1090
- [18] Macedo M, Martins JL, Freitas Filho LG. Sacral ratio and fecal continence in children with anorectal malformations. *BJU Int* 2004; 94(6): 893-4.
[http://dx.doi.org/10.1111/j.1464-410X.2004.05053.x] [PMID: 15476529]
- [19] Kajbafzadeh AM, Nejat F, Abbaslou P. Comparison of Sacral ratio in normal children and children with urinary and/or fecal complains. *Iran J Pediatric* 2008; 18(1): 57-61.
- [20] Yousefichaijan P, Cyrus A, Dorreh F, Mohtasham M, Hafez Qoran F, Goldust M. Sacral index in children suffering from different grades of VUR. *PJBS* 2013; 16(11): 545-7.
[PMID: 24498825]
- [21] Ehsanipour F, Gharouni M, Rafati AH, Ardalan M, Bodaghi N, Otoukesh H. Risk factors of renal scars in children with acute pyelonephritis. *Braz J Infect Dis* 2012; 16(1): 15-8.
[http://dx.doi.org/10.1590/S1413-86702012000100003] [PMID: 22358350]
- [22] Sobouti B, Hooman N, Movahed M. The effect of vitamin E or vitamin A on the prevention of renal scarring in children with acute pyelonephritis. *Pediatr Nephrol* 2013; 28(2): 277-83.

[<http://dx.doi.org/10.1007/s00467-012-2308-4>] [PMID: 23052650]

- [23] Javadi Nia S, Noorbakhsh S, Izadi A, Soheyli pour F, Tabatabaei A, Shokrollahi. MR. Comparison of vitamin A, D & zinc serum levels between children with urinary tract infection and control group in two University Hospital. TUMJ 2013; 71(4): 244-9. [Persian].
- [24] Yousefichaijan P, Dorreh F, Shahsavari S, Pakniyat A. Comparing between results and complications of doing voiding cystourethrogram in the first week following urinary tract infection and in 2-6 weeks after urinary tract infection in children referring to a teaching hospital. J Renal Inj Prev 2016; 5(3): 144-7.
[<http://dx.doi.org/10.15171/jrip.2016.30>] [PMID: 27689111]
- [25] Kajbaf Zadeh A, Nejat F, Abbaslou P. Comparison of sacral ratio in normal children and children with urinary and/or faecal complaints. Iran J Pediatr 2008; 18(1): 57-61.

© 2018 Kandarini *et al.*

This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International Public License (CC-BY 4.0), a copy of which is available at: <https://creativecommons.org/licenses/by/4.0/legalcode>. This license permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.