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Original Article

The Nutcracker Syndrome: an Underdiagnosed Cause for High Grade Varicocele

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Abstract

Background: The nutcracker syndrome represents a clinical condition caused by compression of the left renal vein (LRV) between the superior mesenteric artery (SMA) and the aorta. One of its manifestations is left-sided varicocele. The aim of this study is to determine the prevalence of nutcracker syndrome in patients with primary and recurrent high grade left-sided varicocele.

Methods: Fifty patients with primary and recurrent high grade left-sided varicocele were enrolled in this study. Color Doppler ultra-sonography (US) of renal vessels was done and diameter of LRV and peak systolic velocity (PSV) were measured in renal hilum and in site of compression of LRV between SMA and the aorta and then magnetic resonance angiography (MRA) of renal vessels was done.

Results: Thirty six patients (72%) had primary high grade varicocele and 14 patients (28%) had recurrent high grade varicocele. Twelve patients (33%) with primary high grade varicocele and seven patients (50%) with recurrent varicocele had evidences of NCS in color Doppler US and MRA. The differences of LRV diameter in NCS group and in patients without NCS were statistically significant ($P<0.001$).

The differences of PSV in the LRV at the hilar portion in the NCS group and in the patients without NCS were not statistically significant.

The differences of PSV in the LRV at the aortomesenteric portion in the NCS group and in the patients without NCS were statistically significant ($P< 0.001$).

In all patients with NCS, MRA showed dilatation and compression of LRV at site of passage between aorta and SMA.

Conclusion: NCS should be suspected in patients with high grade primary and recurrent varicocele.

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Keywords ● Nutcracker syndrome ● varicocele ● left renal vein hypertension

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Introduction

The nutcracker syndrome is caused by compression of the left renal vein (LRV) as it passes between the aorta and the superior mesenteric artery (SMA) that results in raising the pressure in the LRV and development of collateral veins. The term nutcracker syndrome dates back to the anatomical description by Grant who stated that "the left

renal vein as it lies between the aorta and the superior mesenteric artery resembles a nut between the jaws of a nutcracker".[1]

The LRV hypertension can promote the development of collaterals of the renal pelvis and this plexus of abnormal hypertensive veins causes microhematuria or gross hematuria.[2-4] Other possible symptoms include left flank pain,[5] left sided varicocele,[6] pelvic congestion,[7] chronic fatigue syndrome,[8] and orthostatic proteinuria.[9]

The aim of this study was to report our experience with the diagnosis of nutcracker syndrome in patients with primary and recurrent high grade varicocele and review the treatment options for this syndrome.

Patients and Methods

From December 2004 to March 2006, 50 male patients (mean age 22.9 years) with primary and recurrent high grade (grade III; large and visible through the scrotal skin) left-sided varicocele were enrolled in this study. The study protocol was described thoroughly for the patients and a verbal informed consent was obtained from all the participants.

All the patients were physically examined and the grade of varicoceles was determined by two urologists based on the international grading system.[10]

After documentation of high grade varicocele, color Doppler ultrasonography of renal vessels was done. Anteroposterior (AP) diameter of LRV and peak systolic velocity (PSV) in renal hilum and in the site of compression of LRV between the SMA and the aorta were measured.

For better evaluation of the anatomy of LRV and its relationship with SMA and abdominal aorta, magnetic resonance angiography (MRA) was done for those patients who had evidences of nutcracker syndrome in color Doppler ultrasonography. All the patients who met the criteria for nutcracker syndrome were selected.[11] The data were analyzed using SPSS software version 15. Chi-Square, *t*, and Mann-Whitney tests were used and $P<0.05$ was considered statistically significant.

Results

Of the 50 patients 36 (72%) had primary high grade varicocele and 14 (28%) patients had recurrent high grade varicocele. Nineteen (38%) patients had evidences of nutcracker syndrome in color Doppler ultrasonography and MRA (positive group), and 31 (62%) patients had no evidence of nutcracker syndrome (negative group).

Twelve (33.3%) out of the 36 patients with primary high grade varicocele had evidences of nutcracker syndrome and 7 (50%) of the 14 patients with recurrent grade III varicocele had evidences of this syndrome. There were not statistically significant differences between these two groups ($P>0.05$).

The mean ± SD of LRV diameter in positive group was 10.91±2.27 mm and in negative group was 6.83±1.50 mm. The difference was statistically significant ($P<0.001$).

The mean ± SD of PSV in the LRV at renal hilum for positive and negative groups were 19.21±6.10 cm/sec and 21.09±5.60 cm/sec, respectively. The difference was not statically significant ($P>0.05$).

The mean ± SD of PSV in the LRV at site of compression of LRV between SMA and the aorta for positive and negative groups were 93±27.46 cm/sec and 44.06±12.41 cm/sec, respectively. The difference was statistically significant ($P<0.001$).

In the positive group, MRA revealed dilatation of LRV and its narrowing at the segment between SMA and the aorta.

Discussion

The nutcracker syndrome is a vascular abnormality of LRV. In this syndrome, LRV is compressed in the angle created by the aorta and the SMA, which results in an increased venous pressure and development of collateral veins.

The underlying pathophysiology of the nutcracker syndrome is not fully understood. One hypothesis for the narrowing of the aortomesenteric angle is a thin body shape and decreased amounts of perirenal fat. Wendel et al. have proposed that posterior renal ptosis with stretching of the LRV over the aorta may be a factor.[12] In a recent study, Hohenfellnet et al. demonstrated that abnormal branching of the SMA from the aorta was the underlying cause of the nutcracker syndrome.[13]

The most common clinical manifestation of the nutcracker syndrome is intermittent macroscopic or microscopic hematuria.[14] De Schepper was the first researcher who showed the relationship between nutcracker syndrome and gross hematuria in a 16-year-old boy.[15] The cause of hematuria in the nutcracker syndrome is LRV hypertension and the development of high pressure thin walled-varicose around the renal pelvis, which are likely to rupture at the calyceal fornices, or communication between dilated venous sinuses and adjacent renal calices.[16,17]

Nishimura et al. reported that 88% (14 of 16) of the patients with left renal bleeding of unknown origin in their study had LRV hypertension.[17] Left renal vein hypertension can also cause varicocele in the male.

In our study, 50 patients with primary and recurrent high grade varicocele were chosen.

Thirty three percent of the patients with primary high grade varicocele and 50% of the patients with recurrent high grade varicocele had evidences of the nutcracker syndrome. These clinical presentations emphasize the importance of a complete sonographic evaluation of the left kidney in patients presenting with high grade varicocele, specially with recurrent varicocele.

Diagnosis of the nutcracker syndrome is difficult because its clinical manifestation and paraclinical investigations are usually not remarkable and specific. In addition, radiographic investigations may fail to detect the LRV hypertension.[18]

Although the most direct method for diagnosis of the nutcracker syndrome is left renal venography and measurement of the pressure gradient between the LRV and IVC, such examinations are very invasive. On the other hand, the pressure gradient depends on the intensity of development of the collateral circulation through gonadal, capsular, suprarenal, lumbar, azygos, and periureteral veins. And a clear cut-off between normal and pathological pressure gradient values does not exist yet.[19] Nevertheless, the normal reno-caval mean pressure gradient ranges from 0 to 1 mm Hg, while pressure gradient of 3 mm Hg or more is deemed to be significant.[20]

Color Doppler ultrasonography is a useful method for diagnosis of the nutcracker syndrome and may be the diagnostic method of choice in the screening of this syndrome.[21] Kim et al. demonstrated that measurement of the AP diameter and PSV in hilar portion of the LRV and in aortomesenteric angle could be used for diagnosis of the nutcracker syndrome.[21]

Computed tomographic (CT) angiography or MRA are the most reliable tools to demonstrate LRV entrapment, compression, and the development of vein network.[19] CT angiography has become the investigation of choice in many centers but it has the disadvantage of radiation exposure. Kaneko and colleagues showed that three dimensional helical computed tomography (3 D helial CT) was useful for diagnosis of the nutcracker syndrome.[22]

MRA provides a non-invasive, radiation-free alternative to CT angiography in the diagnosis of this syndrome. Abnormalities noted on MRA in cases of nutcracker syndrome include dorso–lateral torsion of the left kidney, abnormally high course and dilatation of the LRV and abnormal configuration of SMA's origin.[23]

There are several treatment options for the syndrome such as conservative management, intravascular stents, and open surgical procedures. For patients with microhematuria, and normal hemogram, conservative management and close follow up is the preferred strategy.[23] Patients with persistent gross hematuria and flank pain or those with recurrent high grade varicocele are indicated for intervention. Experience with transluminal balloon angioplasty and stenting of the LRV are limited to a number of case reports.[24-26]

Although endovascular stenting is a simple and interesting option but stents in the venous system have several complications such as fibromuscular hyperplasia, venous occlusion, proximal migration, and embolization. Currently, the usual open surgical procedures for treatment of the NCS are transposition of the LRV and renal autotransplantation.[11] The transposition of the LRV was first described by Gilvernet for mobilization of the right kidney in cases of extensive damage to the lumbar ureter.[27] Stewart and Reiman used this technique for the treatment of nutcracker syndrome.[28] Hohenfellner et al. stated that transposition of the LRV was an efficient surgical approach to treat the syndrome. They successfully treated seven out of their eight patients with nutcracker syndrome associated with recurrent gross hematuria and flank pain by transposition of the LRV.[29] We have successfully used this method to treat recurrent varicocele too.[11]

Renal autotransplantation has been performed by Shokeir et al. They achieved very good results and hematuria ceased in all the patients.[30] Recently Ali-el-Dein and colleagues recommend renal autotransplantation for the treatment of the nutcracker syndrome.[31]

Although renal autotransplantation may offer the maximal efficacy in term of normalizing renal venous circulation, however, it is a more invasive procedure than transposition of the LRV, necessitating a wider exposure, an additional arterial anastomosis and tends to longer renal ischemia.[29] So it seems that transposition of renal vein is the suitable procedure for nutcracker syndrome.

Conclusion

This study showed that the nutcracker syndrome is not else considered a rare vascular anomaly of the LRV and urologists should suspect this condition in patients with unexplained hematuria and flank pain and based on our results in patients with primary or recurrent high grade varicocele.

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References

1 Grant JCB. Methods of anatomy. Baltimore: Williams and wilkins; 1937. p. 158.

2 Macmahon HE, Latorraca R. Essential renal hematuria. *J Urol* 1954; 71: 667-76.
3 Low AI, Matz LR. Haematuria and renal fornical lesion. *Br J Urol* 1972; 44: 681-91.
4 Weiner SN, Bernstein RG, Morehouse H, Golden RA. Hematuria secondary to left peripelvic and gonadal vein varices. *Urology* 1983; 22: 81-4.
5 Takemura T, Iwasa H, Yamamoto S, et al. Clinical and radiological features in four adolescents with nutcracker syndrome. *Pediatr Nephrol* 2000; 14: 1002-5.
6 Zerhouni EA, Siegelmans SS, Walsh PC, White RI. Elevated pressure in left renal vein in patients with varicocele: preliminary observation. *J Urol* 1980; 123: 512-3.
7 Scultetus AH, Villavicencio JL, Gillespie DL. The nutcracker syndrome: its role in the pelvic venous disorders. *J Vasc Surg* 2001; 34: 812-9.
8 Takahashi Y, Ohta S, Sano A, et al. Does severe nutcracker phenomenon cause pediatric chronic fatigue? *Clin Nephrol* 2000; 53: 174-81.
9 Park SJ, Lim JW, Cho BS, et al. Nutcracker syndrome in children with orthostatic proteinuria: diagnosis on the basis of Doppler sonography. *J Ultrasound Med* 2002; 21: 39-45.
10 Goldstein M. Surgical management of male infertility and other scrotal disorders. In Walsh PC, Retik AB, Vaughan ED, Wein AJ, Campbell's Urology. Vol 2. Philadelphia; Saunders; 2002. p. 1532-87.
11 Salehipour M, Khezri A, Rasekhi A, Zand F. Left renal vein transposition for treatment of the Nutcracker syndrome. *Arch Iran Med* 2006; 9: 161-2.
12 Wendel RG, Crawford ED, Hehman KN. The Nutcracker phenomenon: an unusual cause for renal varicosities with hematuria. *J Urol* 1980; 123: 761-3.
13 Hohenfellner M, Steinbach F, Schultz-Lampel D, et al. The nutcracker syndrome: new aspects of pathophysiology, diagnosis and treatment. *J Urol* 1991; 146: 685-8.
14 Little AF, Lavoipierre AM. Unusual clinical manifestation of the nutcracker syndrome. *Australas Radiol* 2002; 46: 197-200.
15 De Schepper A. Nutcracker phenomenon of the renal vein causing left renal vein pathology. *J Belge Rad* 1972; 55: 507-11.
16 Beinard C, Sniderman KW, Saddekni S, et al. Left renal vein hypertension: A cause of occult haematuria. *Radiology* 1982; 145: 647-50.
17 Nishimura Y, Fushiki M, Yoshida M, et al. Left renal vein hypertension in patients with left renal bleeding of unknown origin. *Radiology* 1986; 160: 663-7.
18 Russo D, Minutolo R, Iaccarino V, et al. Gross hematuria of uncommon origin: the nutcracker syndrome. *Am J Kidney Dis* 1998; 32: E3.
19 Lidove O, Orozco R, Gucry B, et al. A young woman with intermittent macroscopic haematuria. *Nephrol Dial Transplant* 2001; 16: 853-5.
20 Beinart C, Sniderman KW, Tamura S, et al. Left renal vein to inferior vena cava pressure relationship in human. *J Urol* 1982; 127: 1070-1.
21 Kim SH, Cho SW, Kim HD, et al. Nutcracker syndrome: diagnosis with Doppler US. *Radiology* 1996; 198: 93-7.
22 Kaneko K, Kiya K, Nishimura K, et al. Nutcracker phenomenon demonstrated by three-dimensional computed tomography. *Pediatr Nepbrol* 2001; 16: 745-7.
23 Ahmed K, Sampath R, Khan MS. Current trends in the diagnosis and management of renal nutcracker syndrome: a review. *Eur J Vasc Endovasc Surg* 2006; 31: 410-6.
24 Takahashi Y, Sano A, Matsuo M. An effective "Transluminal ballon angiography" therapy for pediatric chronic fatigue syndrome with nutcracker phenomenon. *Clin Nephrol* 2000; 53: 77-8.
25 Neste M, Narasimham DL, Belcher KK. Endovascular stent placement as a treatment for renal venous hypertension. *J Vasc Intervent Radiol* 1996; 7: 859-61.
26 Park YB, Lim SH, Ahn JH, et al. Nutcracker syndrome: intravascular stenting approach. *Nephrol Dial Transplant* 2000; 15: 99-101.
27 Gil-Vernet JM. Descent of the right renal vein. *J Urol* 1978; 120: 668-70.
28 Stewart BH, Reiman G. Left renal venous hypertension "Nutcracker" syndrome: managed by direct renocaval reimplantation. *Urology* 1982; 20: 365-9.
29 Hohenfellner M, D'Elia G, Hampel C, et al. Transposition of the left renal vein for treatment of the nutcracker phenomenon: long-term follow-up. *Urology* 2002; 59: 354-7.
30 Shokeir AA, El-Diasty TA, Ghoneim MA. The nutcracker syndrome: new methods of diagnosis and treatment. *Br J Urol* 1994: 74: 139-43.
31 Ali-El-Dein B, Osman Y, Shehab El-Din AB, et al. Anterior and posterior nutcracker syndrome: A report on 11 cases. *Transplantation Proceedings* 2003; 35: 851-3.