Mini review

Posterior nut-cracker syndrome: Urologist's perspective – A mini review

Bhaumik B. Barad[1], Sriram Krishnamoorthy[2], Natarajan Kumaresan[3]

[1] Senior Registrar, [2, 3] Professor, Department of Urology, Sri Ramachandra Institute of Higher Education & Research, Chennai,600116, Tamil Nadu, India

(Received: June 2020 Revised: April 2021 Accepted: April 2021)

Corresponding author: **Sriram Krishnamoorthy.** Email: sriramuro@gmail.com

ABSTRACT

Posterior Nut Cracker Syndrome (PCNS) is a rare clinical condition that occurs when the left renal vein gets compressed between the abdominal aorta and vertebral body. Posterior nutcracker phenomenon is a common anatomical abnormality, which is totally asymptomatic and diagnosed in a routinely performed abdominal imaging. The pressure gradient that develops between the renal vein and the inferior vena cava is the basic reason for all the features associated with this condition. Left renal venous entrapment would result in stagnation of blood in gonadal vessels that results in cascading effect resulting in a venous congestion and increased resistance to arterial blood flow in the kidney. Patients with pelvic congestion syndrome present with left loin pain and unilateral left varicocele. Gastrointestinal symptoms and arterial hypertension may also be the presenting symptoms. The symptoms depend upon the degree of pressure in renal veins and gonadal veins. When the dilated veins communicate with renal calyx, haematuria occurs. PNCS is best managed based on the severity of symptoms and the extent of clinical manifestations. Treatment options include conservative treatment, intra-vascular stents, chemical cauterisation, open surgical intervention and finally if everything fails, nephrectomy. PCNS is a rare entity that affects mostly females and can present with a variety of signs and symptoms. A high index of clinical suspicion is needed to achieve a prompt diagnosis. Conservative treatment is recommended for patients with mild symptoms. Severely symptomatic patients might benefit from endovascular treatment.

Keywords: Hematuria; loin; kidney; renal vein; nutcracker.

INTRODUCTION

Nutcracker syndrome is a clinical manifestation of a prolonged pressure over the left renal vein (LRV; 1). Mechanical compression of LRV between aorta and superior mesenteric artery is Anterior Nutcracker syndrome (ANCS) and that between the abdominal aorta and vertebral body is posterior Nutcracker syndrome (PNCS; 2,3). The term ANCS is a relatively common condition which is more often considered synonymous with NCS. While it is a common observation that the ANCS could result in left sided varicocele, the PNCS needs more detailed description, as the Retro-aortic left renal vein (RLRV) causing venous compression would be of more relevance to the urologist and often gets missed out during evaluation.

Pathophysiology

PNCS occurs when the left renal vein gets compressed between the abdominal aorta and vertebral body (4, 5). Due to this mechanical compression on LRV, a reno caval pressure gradient is created which is the fundamental reason for all symptoms associated with PNCS (6). Stasis of blood in the gonadal veins leads to heaviness or discomfort in loin, that may delay the diagnosis (7). As PNCS is often under-reported, its clinical manifestations mimic and are often mistaken as presentations of other more common illnesses (8). LRV compression between the aorta and vertebral body would result in a rise in the venous pressure in the distal venous portion. This would cause a decrease in flow and also a temporary retention of venous blood. This will initiate a cascading effect resulting in a venous congestion, increased resistance to arterial blood flow in the kidney, leading onto a collateral blood flow. The collateral blood flow would act as a 'pop off' mechanism, resulting in a reduction in the arterial resistance and increase in renal perfusion. An upright erect posture further worsens the angulations, leading on to an exacerbated hemodynamic response, which are responsible for the various clinical manifestations (9).

It is important to differentiate Posterior nutcracker syndrome (PCNS) from Nutcracker Phenomenon (10). This phenomenon is a common anatomical abnormality, which is totally asymptomatic and diagnosed in a routinely performed abdominal imaging. On the other hand, PCNS includes a variety of typical or atypical symptoms that the patient could present with.

Why is it important for urologists?

Loin pain and haematuria have always been perplexing problems for the urologists since time immemorial. Most patients with PNCS present with vague loin pain or upper abdominal discomfort. In the absence of overt haematuria, most of such patients rarely present themselves to urologists. Presence of either micro or macroscopic haematuria

adds to the confusion for the primary care physicians or nephrologists, where there is a common tendency to make a diagnosis of glomerulonephritis.

Clinical Pathologists have tiresomely examined renal biopsy specimens to identify the probable cause for recurrent unexplained gross haematuria associated with loin pain. Various authors have described renal cysts, angiomas, microhaemangiomas, vascular anomalies, and renal veno-calyceal fistulae in the renal fornices as potential causes for this condition (11). Lack of specific clinical findings necessitates a higher suspicion for the diagnosis of PNCS. Non-invasive CT angiogram may be needed to confirm PNCS (12). On many occasions, patients with Posterior nut cracker syndrome present with vague epigastric discomfort, dyspepsia, vomiting, left loin pain and micro haematuria. The presence of such atypical symptoms may prompt the patients to consult a physician, causing further delay in making a proper diagnosis. The purpose of this manuscript is to highlight to the clinicians and urologists the rarity of such a condition and also to highlight the myriad of urological symptoms that the PNCS can present with, so that an early diagnosis is made and treated appropriately.

Classification

Hoeltl *et al.,* had classified the RLRV into 2 distinct types: Type 1 is associated with an obliterated ventral preaortic limb of the LRV, but persistent dorsal retroaortic limb which subsequently joins the IVC in the orthotopic position. On the other hand, obliteration of ventral limb of LRV can produce Type 2 anomaly. Jong *et al* in 2010 subsequently reported the congenital anomalies of the RLRV as four types. Type 3 anomaly is the circumaortic LRV. One vein passes posterior and the other vein passes anterior to the aorta to join the IVC. In Type 4 anomaly, the ventral preaortic limb of the LRV is obliterated, and the remaining dorsal limb becomes the RLRV and joins the left common iliac vein (13). Though Posterior nut cracker syndrome by definition can be seen in all 4 types, it is classically seen in Type 1 anomaly. Fig 1 describes the schematic illustration of the types of RLRV (13).

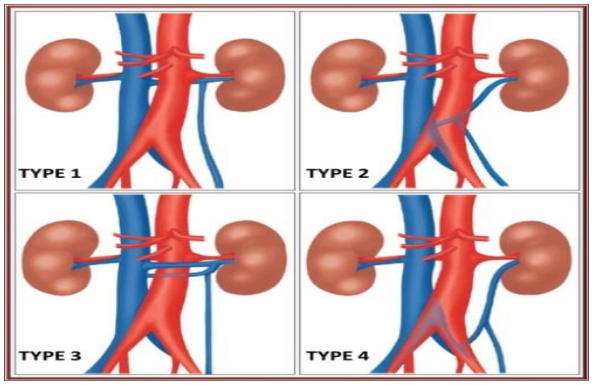

Fig. 1: Schematic illustration of types of retro-aortic left renal vein (image reproduced after obtaining prior written permission from the authors of Ref. 13)

Epidemiological characteristics

The development of inferior venacava by itself is such a complex process that efforts to make the understanding of development of renal vein make it even more complicated. Left renal vein entrapment, also known as Nut cracker syndrome, was first described by El-Sadr and Mina in 1950(14). However, the term Nut cracker Syndrome was first used by Chait *et al.*,(15), though the Belgian physician De Schepper is the one, who was first credited with this terminology in 1972(16).The overall incidence of RLRV was reported as 3% and a vast majority of them are asymptomatic(17).

Demographic characteristics

Most of the patients remain asymptomatic throughout their lifetime. While most patients remain healthy, many of the symptomatic ones develop clinical manifestations during their second or third decade of life (18). It usually affects women more than men and in most cases present in the 3rd or 4th decades of life (19). Some patients show only microscopic haematuria, which may be picked up during routine evaluation. Rudloff observed a second peak to occur in middle aged women, who might present with symptoms resulting from pelvic venous congestion due to massive reflux of blood in gonadal vein and pelvic varices (20). Although anecdotal reports of NCS affecting the siblings have been reported, NCP is not established to have a hereditary transmission (21). Various pathophysiological changes that happen during puberty, including a sudden spurt in the body height, angulation that develops between the vertebral body and aorta and a low body mass index are also considered to be the reasons for NCS (22).

Clinical characteristics

Other patients may present with left loin pain with unilateral left varicocele due to venous stasis at gonadal vessel, also known as Pelvic congestion syndrome. Gastrointestinal symptoms and arterial hypertension may occasionally be the presenting symptoms (23). The severity of symptoms varies depending on the renal venous pressure, engorgement of gonadal veins, left suprarenal vein and ascending lumbar veins (24). Haematuria may be the result of communication between dilated venous sinuses and adjacent renal calices.

Microhaematuria in PCNS, though rare, is not so uncommon, if specifically looked for. The mechanical compression of the LRV between the aorta and the vertebral body results in a rise in pressure gradient between the LRV and the vena cava. This rise in pressure gradient, in turn leads to the rupture of the membranous barrier between the smaller veins and the collecting system in the renal fornix, resulting in micro haematuria (25,26). Ahmed also considered a pressure gradient of 3 mm Hg or more as indicative of renal hypertension. Though this

was a study done on patients with Anterior Nut cracker syndrome, Lopatkin postulated that haematuria may be the result of communication between dilated venous sinuses and adjacent renal calices and observed in patients with PNCS also (27). However pressure gradients have been reported to vary with position and hydration, as well as the degree of collateralization. Daily et al had reported a direct correlation between the left renal vein pressure (LRVP) and the degree of haematuria (28). However, Park et al, in their systematic review on PCNS, had found no such direct correlation and observed that patients with lower LRVP of 4.4 mm Hg manifested with macro haematuria while patients with higher LRVP of 8 mm Hg showed only a microhaematuria (29,30).

Treatment

Patients with PNCS are best managed based on their symptomatology, the clinical manifestations, severity of LRVP and hypertension. The various treatment options available include Conservative treatment, intra-vascular stents, chemical cauterisation, open surgical intervention and finally if everything fails, nephrectomy.

In patients with mild haematuria and in young individuals, who are willing to come for a regular follow up, conservative and supportive treatment is offered. Young adults, aged less than 18 years can be followed up for a minimum period of 2 years as there is a 75% chance that there may be a complete resolution of microhaematuria(31). Endovascular stenting is a viable option for patients who have bothersome pain and hypertension due to elevated LRVP(32). However, its future role in the management of this condition remains to be established and the potential complications like Fibromuscular dysplasia, stent migration, thrombosis, restenosis and embolization have to be borne in mind (33).

Few anecdotal reports on Intra Pelvic Chemical Cauterization using 0.1% Silver nitrate through ureteric catheter placement are available in literature (34). Gong et al observed that gross haematuria improved with intra pelvic instillation and the patient remained symptom free for the next 16 months follow up. However, more case series and meta-analysis are needed to validate this claim. Open/Laparoscopic surgical procedures include left renal vein transposition andrenal auto-transplantation (35, 36, 37). In intractable cases, when all conservative treatment fails or when haematuria persists even after transposition of left renal vein, nephrectomy is recommended as a palliative measure (38).

CONCLUSION

Posterior Nutcracker Syndrome due to the compression noted in the Retro aortic renal vein is a rare entity that affects mostly females and can present with a variety of signs and symptoms. This review article reinforces the need for a high index of clinical suspicion in order to achieve a correct and prompt diagnosis. Conservative treatment is recommended for patients with mild symptoms. Patients with serious impairment or severe symptoms may benefit from a surgical or endovascular intervention.

ACKNOWLEDGEMENT

The authors profusely thank Professor LEE SANG DON M.D., PhD, for permitting us to reproduce the Fig. 1 from their manuscript, The Clinical Significance of a Retroaortic Left Renal Vein, published in Korean Journal of Urology, Korean J Urol 2010;51:276-280.

CONFLICTS OF INTEREST

Authors declare no conflicts of interest.

REFERENCES

1. Hanna, H. E., Santella, R. N., Zawada, E. T., Jr, Masterson, T. E. Nutcracker syndrome: an underdiagnosed cause for haematuria? S D J Med. 1997 Dec; 50(12): 429-436.
2. Gozzo, C., Farina, R., Foti, P. V., Iannace, F. A., Conti, A., Pennisi, I., et al., Posterior nutcracker syndrome: a case report. J Med Case Rep. 2021; 1; 15(1): 42.
3. Gulleroglu, K., Gulleroglu, B, Baskin, E. Nutcracker syndrome. World J Nephrol. 2014; 3(4): 277-81.
4. Jang, Y. B., Kang, K. P., Lee, S., Kim, W., Kwak, H. S., Park, S. K. Posterior nutcracker phenomenon. Nephrology, Dialysis, Transplantation. 2005; 20: 2573-2574.
5. Rassi, I., Khabbaz, Z., Chelala, D., Jebara, V. A. A new variant of the posterior nutcracker phenomenon. J Vasc Surg. 2010; 51(5): 1279.
6. Calàbria, C. H., Gómez, Q. S., Cerqueda, S. C., de la Presa, B. R., Miranda, A., Alvarez-Castells, A. Nutcracker or left renal vein compression phenomenon: multidetector computed tomography findings and clinical significance. Eur Radiol. 2005 Aug; 15(8): 1745-1751.
7. Ozkan, M. B., Bilgici, C. M., Hayalioglu, E. Anterior and posterior nutcracker syndrome accompanying left circumaorticrenalvein in an adolescent: case report. Arch Argent Pediatr. 2016; 114: e114-116.
8. Noorani, A., Walsh, S. R., Cooper, D. G., Varty, K. Entrapment syndromes. Eur J VascEndovasc Surg. 2009; 37: 213-220.
9. Ananthan, K., Onida, S., Davies, A. H. Nutcracker syndrome: an update on current diagnostic criteria and management guidelines. Eur J VascEndovasc Surg. 2017 Jun;53(6): 886-894.
10. Shin, J. I., Lee, J. S. "Nutcracker phenomenon or nutcracker syndrome?" Nephrology Dialysis Transplantation, 2005 20(9): 2015.
11. Stewart, B. H., Reiman, G. Left renal venous hypertension "nutcracker" syndrome. Managed by direct renocaval reimplantation. Urology. 1982 Oct; 20(4): 365-369.
12. Shah, D., Qiu, X., Shah, A., Cao, D. Posterior nutcracker syndrome with left renal vein duplication: An uncommon cause of hematuria. Int J Surg Case Rep. 2013; 4(12): 1142-1144.
13. Nam, J. K., Park, S. W., Lee, S. D., Chung, M. K. The Clinical Significance of a Retroaortic Left Renal Vein. Korean J Urol. 2010 Apr; 51(4): 276-280.
14. El-Sadr, A. R., Mina, E. Anatomical and surgical aspects in the operative management of varicocele. Urol Cutaneous Rev. 1950; 54(5): 257-262.

15. Chait A., Matasar, K. W., Fabian, C. E., Mellins, H. Z. Vascular impressions on the ureters. Am J Roentgenol Radium TherNucl Med. 1971; 111(4): 729-749.
16. de Schepper, A. "Nutcracker" phenomenon of the renal vein and venous pathology of the left kidney [in Dutch]. J BelgeRadiol. 1972; 55(5): 507-511.
17. Aljabri, B., MacDonald, P. S., Satin, R., Stein, L. S., Obrand, D. I., Steinmetz, O. K. Incidence of major venous and renal anomalies relevant to aortoiliac surgery as demonstrated by computed tomography. Ann Vasc Surg. 2001; 15(6): 615-618.
18. Kurklinsky, A. K., Rooke, T. W. Nutcracker phenomenon and nutcracker syndrome. Mayo Clin Proc 2010; 85(6): 552-559.
19. Fernandes, P. J., Amorim, R., Gomes, M. J., Oliveira, V., Reis, A., Ribeiro-Castro, J. Posterior nutcracker syndrome with left renal vein duplication: a rare cause of haematuria in a 12-year-old boy. Case Rep Urol. 2012; 10: 1-4.
20. Rudloff, U., Holmes, R. J., Prem, J. T., Faust, G. R., Moldwin, R., Siegel, D. Mesoaortic compression of the left renal vein (nutcracker syndrome): case reports and review of the literature. Ann Vasc Surg. 2006; 20(1): 120-129.
21. Matsukura, H., Arai, M., Miyawaki, T. Nutcracker phenomenon in two siblings of a Japanese family. Pediatr Nephrol 2005; 20: 237-238.
22. Ozkurt, H., Cenker, M. M., Bas, N., Erturk, S. M., Basak, M. Measurement of the distance and angle between the aorta and superior mesenteric artery: normal values in different BMI categories. SurgRadiolAnat 2007; 29: 595-599.
23. Nickavar, A. Nutcracker syndrome; a rare cause of hematuria. J Nephropathol. 2016; 5(4): 144-145.
24. Shokeir, A. A., el-Diasty, T. A., Ghoneim, M. A. The nutcracker syndrome: new methods of diagnosis and treatment. Br J Urol. 1994; 74(2): 139-143.
25. Buschi, A. J., Harrison, R. B., Brenbridge, A. N. A. G., Williamson, B. R. J., Gentry, R. R., Cole, R. Distented left renal vein; CT/sonographic normal variant. AJR 1980; 135: 339-342.
26. Ahmed, K., Sampath, R., Khan, M. S. Current trends in the diagnosis and management of renal nutcracker syndrome: a review. Eur J VascEndovascSurg. 2006; 31: 410-416.
27. Lopatkin, N. A., Morozov, A. V., Lopatkina, L. N. Essential renal haemorrhages. Eur Urol. 1978; 4: 115-119.
28. Daily, R., Matteo, J., Loper, T., Northup, M. Nutcracker syndrome: symptoms of syncope and hypotension improved following endovascular stenting. Vascular. 2012; 20: 337-341.
29. Sato, Y., Yoshimura, A., Sakai, H., Yogi, S., Kai, Y., Ideura, T. A case of posterior nutcracker syndrome occurring in pregnancy. Nihon Jinzo Gakkai Shi. 1997; 39: 790-793.
30. Granata, A., Clementi, A., Floccari, F., Di Lullo, L., Basile, A. An unusual case of posterior nutcracker syndrome. Clin Exp Nephrol. 2014; 18: 670-671.
31. Shin, J. I., Park, J. M., Lee, S. M., Shin, Y. H., Kim, J. H., Lee, J. S., *et al.*, Factors affecting spontaneous resolution of hematuria in childhood nutcracker syndrome. Pediatr Nephrol. 2005 May 20; 5: 609-613.
32. Segawa, N., Azuma, H., Iwamoto, Y., Sakamoto, T., Suzuki, T., Yamamoto, K., *et al.*, Expandable metallic stent placement for nutcracker phenomenon. Urology 1999; 53: 631-633.
33. Jeanneret, C., Beier, K., von Weymarn, A., Traber, J. Pelvic congestion syndrome and left renal compression syndrome – clinical features and therapeutic approaches. Vasa. 2016; 45: 275-282.
34. Gong, Y., Song, B. O. The nutcracker syndrome. J Urol 2003; 169: 2293-2294.
35. Chen, Y., Xing, J., Liu, F. Left renal vein transposition is effective for posterior nutcracker syndrome. Int J Clin Exp Med. 2014 Dec 15; 7(12): 5925-5927.
36. Salehipour, M., Rasekhi, A., Shirazi, M., Haghpanah, A., Jahanbini, S., Eslahi, S. A. The role of renal autotransplantation in treatment of nutcracker syndrome. Saudi J Kidney Dis Transpl. 2010; 2: 237-241.
37. Xu, D., Liu, Y., Gao, Y., Zhang, L., Wang, J., Che, J., *et al*., Management of renal nutcracker syndrome by retroperitoneal laparoscopic nephrectomy with ex vivo autograft repair and auto transplantation: a case report and review of the literature. J Med Case Rep. 2009; 3: 82.
38. de Macedo, G. L., Dos Santos, M. A., Sarris, A. B., Gomes, R. Z. Diagnosis and treatment of the Nutcracker syndrome: a review of the last 10 years. J Vasc Bras. 2018; 17(3): 220-228.