Review

Diagnostic and Treatment Approach in Case of Aorta Mesenteric Clamp

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Abstract
The article presents anatomical and physiological features of the aorta mesenteric clamp. Diagnostic and treatment features of the pathology were analyzed in order to improve operating procedures. Unfortunately, few published literature data are not the result of multicenter randomized research and indicate the fact that consensus on diagnostic algorithms and therapeutic approach is absent.

Keywords
aorta mesenteric clamp; anatomical and physiological features; diagnostic and treatment algorithm

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Aorta mesenteric clamp (AMC) is a pathology caused by compression of the left renal vein between superior mesenteric artery and aorta [21, 23, 24, 27]. The main clinical symptoms include hematuria, proteinuria, dragging pain in the left lumbar region, left sided varicocele in men and pudendal varicosity in women [55]. The absence of diagnostic procedure algorithm leads to high level of AMC non-detection and diagnostic and therapeutic error. The pathology is rarely diagnosed due to the lack of symptom specificity. Therefore, it deserves special attention concerning the study of diagnostics pathogenesis and the choice of treatment approach.

Anatomy
Normally, superior mesenteric artery arises from aorta at an angle of 90°, is directed ventrally within 4-5 mm, and then falls caudally [20, 34]. This anatomical feature prevents the compression of the left renal vein by the superior mesenteric artery. However, the angle of superior mesenteric artery origin is acute and usually constitutes 38-56°C in case of superior mesenteric artery syndrome [42, 43, 51].

Embryology
The development of inferior vena cava occurs at the fourth week of gestation from three pairs of fetal veins: posterior cardinal veins, subcardinal veins and supracardinal veins [32]. These vessels form four segments of inferior vena cava, namely infrarenal, renal, suprarenal and hepatic ones, by the eighth week of gestation [82]. Normally, the posterior portion of the described vascular structures degenerates, and the anterior one develops. For example, the left renal vein originates from the anterior part of the vessels described above [67]. If degeneration of the posterior cardinal veins is disturbed during gestation for some reasons, annular left renal vein originates. Pathological degeneration of the anterior portion of the cardinal veins leads to retroaortic location of the left renal vein [58].

History of the study
The first description of this abnormality was made by anatomist Grant in 1937. AMC syndrome was described clinically by A.R. El.-Sadr, E.Minafor the first time in 1950 [23]. In 1971, Chait et al. described abdominal aorta and superior mesenteric artery as two hands of a “nutcracker” compressing the left renal vein [13]. This gave the Belgian doctor De Schepper an idea to describe this pathology as “the nutcracker phenomenon” [21].

In 1986 J.L.T. Lau, R. Lo, F.L.Chan, K.K. separately introduced a term “posterior nutcracker syndrome”, i.e. the compression of the left renal vein between the aorta and vertebral column [35] causing secondary hematuria [63, 68, 70, 79]. The studies of K.R.L. Sharper, J.E. Jackson, J. Williams were also especially noteworthy. In 1994, the authors described the combined (posterior and anterior) nutcracker syndrome when the anterior portion of the left renal vein was compressed by the superior mesenteric artery and the posterior portion was clamped between the aorta and vertebral column [40]. According to J.I. Shin, J.S. Lee, M.J. Kim, the pathology was also distinguished when the duodenum was located in front of the aorta and the superior mesenteric artery causing the compression of the left renal vein, i.e. Wilkie’s syndrome [67].
Theories of the origin
Considering the theory of nutcracker syndrome origin, A.A. Schoekeir, T.A. el-Diasty, M.A. Ghoeneim indicated the left kidney ptosis causing the secondary tension of the left renal vein, atypically high position of the left renal vein and atypical branch of the superior mesenteric artery from the aorta [64]. S.P. Pastershank, A. Ariyoshi, K. Nasage suggested that the compression of the left renal vein could be also caused by pancreatic tumors, para-aortic lymphadenopathy, retroperitoneal space tumors, annular gonadal artery, and strangulation fibrosis of the tissues between the superior mesenteric artery and the aorta [54, 9]. R.G. Wendel, E.D. Crawford, K.N. Hehman described also the so-called tethering of the left kidney with tight draping of the left renal vein over the aorta in patients with prominent lumbar lordosis but without involvement of the superior mesenteric artery [79]. M.V. Radisic, D. Feldman, C. Diaz et al. mentioned right-sided AMC caused by the compression of the right renal vein by gravid uterus [60].

Demographic features
J.I. Shin, J.S. Lee, M.J. Kim considered the exact prevalence of the disease to be unknown, but it was slightly higher among women [67] and constituted 78% according to the Mayo Clinic [55]. K. Ahmed, R. Sampath, M.S. Khan indicated that most patients with AMC were from the Far East [6]. The patients' age ranged from childhood to 70, but the most symptomatic patients were at the age of 20-30 [62]. Few reports of this pathology were recorded in the last century due to the non-specific symptoms and limited diagnostic capabilities [21, 23, 24, 27]. A number of scientists such as S. Venkatachalam, K. Bumpus, S.R. Gray Kapadia, B. Lyden, and S. Shishehbor considered that AMC demography was scarcely described in literature resources as a result of symptoms variability and the lack of clear diagnostic criteria [77].

Clinical picture
A.H. Scultetus, J.L. Villavicencio, D.L. Gillespie distinguished the main clinical manifestations of the “nutcracker” syndrome such as left-sided abdominal pain (72.7%), macrohematuria and microhematuria (57.6%), proteinuria (39.4%), anemia (13.39%) [55, 66, 67]. N.M. Wolfish, P.N. McLaine, and D. Martin described also left sided varicocele in men, pudendal varicosity, postcoital pain in women [80]. Another group of researchers, namely C.A. Velasquez, A. Saeyeldin, M.A. Zafar, A.J. Brownstein, Y. Erben noted the pain that usually increased in sitting or standing position, during physical activity and decreased in horizontal position [76, 82]. According to A.A. Schoekeir, T.A. el-Diasty, M.A. Ghoeneim, pain radiation to the internal surface of the thigh and buttock was also typical [64]. According to T. Scholbach, the severity of the clinical symptoms clearly correlated with the level of hypertension in the left renal vein and the degree of its compression [65, 32].

Methods of diagnostics. In the 1980s, N.A. Lopatkin, A.K. Morozov, L.N. Zhynchikova drew attention to the correlation of the pressure gradient indicator between the left renal vein and inferior vena cava which reliably reflected AMC severity in men with varicocele [1].

Attention to this pathology has considerably increased due to the expansion of diagnostic capabilities [3]. Nowadays, Doppler sonography, computed tomography, angiography, MRI, phlebography are used to make diagnosis [48, 57, 83]. According to S. Takebayashi, T. Ueki, N. Ikeda et al., ultrasonic Doppler examination is still the method of choice for patients with suspected AMC due to the high specificity and sensitivity of this method constituting 78-100% [73]. Y. Takahashi, A. Sano, and M. Matsuo suggest that ultrasonic Doppler examination provides an opportunity to estimate the degree of left renal vein stenosis and blood velocity in it [72].

Treatment approach
Treatment approach for patients with AMC has been developed over the past 50 years on the basis of individual clinical observations but not randomized research and can be classified as follows [6]:

- conservative treatment and case follow-up;
- open surgical treatment;
- stenting;
- laparoscopic surgery;
- intrapelvic chemical cauterization.

Conservative treatment and case follow-up
This method is relevant for patients under the age of 18, as well as in case of minimal clinical manifestations [29, 71, 72]. J.I. Shin, J.M. Park, J.S. Lee et al. described cases of spontaneous recovery in children associated with body weight gain leading to adipose tissue enlargement in aorta mesenteric angle and to the reduction or elimination of the left renal vein compression [29, 68].

Alacepril is preferred among other ACE inhibitors in pharmacological therapy, the effect of vein tonics use (Daflon 500 mg 2 times a day) is also noted [31].

Open surgical treatment
The first experience of surgical treatment of a patient with AMC was described by Pastershank in 1974. It consisted in the elimination of fibrous tunnel between aorta and superior mesenteric artery in order to eliminate left renal vein compression. Relapse was not observed during 2 years after the surgery [54]. From then onward, AMC surgical correction has been expanded with a number of interventions such as nephropexy with the removal of renal vein varicosity (this method has not proved its effectiveness), transposition of the left renal vein, transposition of the superior mesenteric artery, kidney autotransplantation, application of gonadal caval anastomosis [9].

Transposition of the left renal vein was first performed in 1982 by Stewart. It consisted in the detachment of the left
renal vein from inferior vena cava, suturing of inferior vena cava defect and reanastomosis below the superior mesenteric artery. The advantages of the left renal vein transposition included a short period of renal ischemia, the disadvantages comprised the risk of the left renal vein thrombosis [33, 34, 61].

According to P.N. Thompson, R.C. Darling, B.B. Chang, D.M. Shah, R.P. Leather, the transposition of the superior mesenteric artery implied the same principle of reanastomosis for the elimination of the left renal vein compression. However, the use of this intervention was limited due to the high risk of intestinal complications [75].

Kidney autotransplantation involved nephrectomy in a living donor and kidney transplantation in ipsilateral or contralateral iliac region [17, 74].

The issue of the gonadal caval anastomosis effectiveness remains controversial [81]. Some authors point to the advantage of this intervention over the transposition of the left renal vein, in particular shorter duration of the operation, namely 108.5 minutes versus 220 minutes, and less blood loss, namely 125 ml of blood versus 450 ml of blood (according to Ehsan Benrashid), others point to a higher risk of relapse in case of gonadal caval stenting (A.A. Sokolov). Generally, AMC open surgical correction has proven successful but its use correlates with a number of complications such as bleeding, thrombosis, intestinal distention.

Stenting

Endovascular stenting of the left renal vein was first mentioned by Neste et al. in 1996 [50]. The authors analyzed 61 cases of endovascular stenting of the left renal vein. Follow-up period lasted from 6 months to 6 years. Complete regression of clinical symptoms was observed in 59 patients. Complications such as stent migration, restenosis, venous occlusion, stent fracture occurred rarely [78]. Two cases of complication were described among 61 patients. The first case was stent protrusion in left renal vein collateral. The second one was stent migration to the right atrium. Both complications were eliminated by open surgical intervention. After the stenting, the authors recommended the use of low molecular weight heparin during 3 days with the transition to clopidogrel for 30 days and aspirin for 3 months [31, 39]. However, some researchers indicated that drop of pressure in the renal vein was not observed in some patients despite the fact that the stent was correctly installed in the narrowest place of the renal vein [63]. Relative simplicity of the procedure and patients’ favorable tolerance led to widespread use of this technique [14, 15, 16].

Extravascular stenting of the left renal vein PTFE graft was first described by Barnes, et al. in 1998. After duodenum mobilization, the left renal vein was isolated and 14F stent graft was placed around the site of the adrenal and gonadal vein falling into the inferior vena cava [10].

Laparoscopic surgery

Scultetus et al. described laparoscopic extravascular stenting with complete symptoms regression in the postoperative period [66]. Chung described the case of laparoscopic distal splenorenal shunt procedure [18], and Hartung described the successful laparoscopic transposition of the left renal vein into the inferior vena cava [30]. However, splenorenal anastomosis may cause complications in the form of venous ischemia due to the fact that the pressure in the portal system is higher than the central venous pressure leading to a steady increase in renal pressure. Xu and co-authors published 2 cases of laparoscopic application of mesenteric-gonadal venous shunt [81].

Intrapelvic chemical cauterization

In 2003, Gong Yu et al. (China) described one-time use of installations of 0.1% solution of silver nitrate into renal pelvis via ureteroscope to a patient with massive hematuria. According to the author, the positive dynamics (disappearance of hematuria) lasted during 16 months of observation but the technique could not be recommended due to the singularity of this study.

Conclusions

Analyzing the literature data on the diagnostic and treatment approach in case of the aorta mesenteric clamp we may draw the following conclusions. First and foremost, there is no consensus regarding the diagnostic algorithm for AMC detection. Secondly, an evidence base (multicenter clinical randomized research) regarding clinical selectivity of treatment approach is insufficient. Thirdly, the pathology is rarely diagnosed due to a number of objective and subjective reasons, and therefore deserves special attention in the study of pathogenesis, diagnosis and choice of treatment approach.

Open surgical treatment and minimally invasive endovascular stenting of the left renal vein remain competitive treatment methods.

Despite the effectiveness of the open surgery, its possibilities are limited by such complications as thrombosis, bleeding, paresis and intestinal ischemia.

The advantages of minimally invasive techniques are relative easiness of implementation, shorter rehabilitation period and better patients’ tolerance. However, the disadvantages of this method include the risk of stent migration, embolism, stent fracture and protrusion.

References

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