UDC 616-089.843+616.61+616.13
DOI: 10.14739/2310-1210.2024.3.299558

Reimplantation of the left renal vein in case of nutcracker syndrome: a 25-year experience of one center

I. I. Kobza[1,A,F], I. R. Nesterenko*[2,B,C,D,E]

[1]Danylo Halytsky Lviv National Medical University, Ukraine, [2]Ivano-Frankivsk National Medical University, Ukraine

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Keywords: vascular compression syndrome, surgical procedures, long-term outcomes.

Zaporozhye medical journal. 2024;26(3):200-203

***E-mail:** nesterenko-irenka@ukr.net

The aim was to assess the long-term outcomes of the left renal vein reimplantation in case of nutcracker syndrome.

Materials and methods. The study included 56 patients with critical stenosis of the left renal vein who underwent left renal vein reimplantation from May 1999 to August 2023. 10 patients were operated on between 1999 and 2013, that provided an opportunity to study long-term outcomes in the period from 7 to 21 years (a retrospective part). 46 patients underwent the surgery between 2018 and 2023 (a prospective part).

Results. According to the long-term outcome analysis of the left renal vein reimplantation conducted in the period from 3 months to 21 years, all the patients reported a gradual regression of clinical symptoms, namely, resolution of pain syndrome, hematuria, proteinuria, erectile dysfunction, dyspeptic phenomena. Ultrasonography detected a statistically significant increase in the left renal vein diameter from 1.90 ± 0.87 mm to 7.50 ± 0.76 mm (p = 0.0123) in the aorto-mesenteric segment after the surgery and a statistically significant decrease in the peak systolic velocity from 187.30 ± 2.95 cm/sec to 38.70 ± 0.76 cm/sec (p = 0.0178) in this area. A statistically significant decrease in the left gonadal vein diameter from 6.60 ± 1.30 to 4.20 ± 0.84 mm (p = 0.0118) after the surgery was noted and a decrease in the left kidney parenchymal thickness from 2.20 ± 0.46 to 1.60 ± 0.54 mm (p = 0.0123) was observed.

Conclusions. Reimplantation of the left renal vein has been proven to be an effective treatment for critical stenosis of the left renal vein.

Ключові слова: судинно-компресійний синдром, хірургічне лікування, віддалені результати.

Запорізький медичний журнал. 2024. Т. 26, № 3(144). С. 200-203

Реімплантація лівої ниркової вени при синдромі Лускунчика: 25-річний досвід одного центру

І. І. Кобза, І. Р. Нестеренко

Мета роботи – оцінити віддалені результати реімплантації лівої ниркової вени при синдромі Лускунчика.

Матеріали і методи. У дослідження залучили 56 пацієнтів із критичним стенозом лівої ниркової вени, яким здійснили реімплантацію лівої ниркової вени (РЛНВ) у період з травня 1999 до серпня 2023 року. У 1999–2013 рр. прооперовані 10 пацієнтів, що дало змогу вивчити віддалені результати в строк від 7 до 21 року (ретроспективна частина); у 2018–2023 рр. прооперовані 46 хворих (проспективна частина). Усі пацієнти запрошені на контрольний огляд, що передбачав опитування, оцінювання об'єктивного статусу та виконання ультразвукової доплерографії (УЗДГ) місця РЛНВ, лівої гонадної вени та лівої нирки.

Результати. Віддалені наслідки РЛНВ проаналізували в термін від трьох місяців до 21 року. Встановили, що всі пацієнти визначають поступовий регрес клінічної симптоматики: зникнення больового синдрому, гематурії, протеїнурії, еректильної дисфункції, диспептичних явищ. На УЗДГ виявлено статистично достовірне збільшення діаметра лівої ниркової вени в аорто-мезентеріальному сегменті після операції (з 1,90 ± 0,87 мм до 7,50 ± 0,76 мм, p = 0,0123) та статистично вірогідне зменшення пікової систолічної швидкості в цій ділянці (з 187,30 ± 2,95 см/с до 38,70 ± 0,76 см/с, p = 0,0178). Встановили статистично достовірне зменшення діаметра лівої гонадної вени після операції (з 6,60 ± 1,30 мм до 4,20 ± 0,84 мм, p = 0,0118) та зменшення товщини паренхіми лівої нирки (з 2,20 ± 0,46 мм до 1,60 ± 0,54 мм, p = 0,0123).

Висновки. Реімплатація лівої ниркової вени довела свою ефективність при критичному стенозі лівої ниркової вени.

The first experience of surgical treatment for nutcracker syndrome (NS) was described by Pastershank in 1974 and consisted in the eradication of the fibrous tunnel between the aorta and superior mesenteric artery (SMA) in order to eliminate the left renal vein (LRV) compression [1]. From then onwards, open surgical correction of aorto-mesenteric compression has been supplemented by a number of interventions, namely, nephropexy with varicose renal vein removal (this method has not proved effective), LRV reimplantation, SMA transposition, kidney autotransplantation, and gonadocaval bypass [2].

Reimplantation of the left renal vein (RLRV) in patients with LRV critical stenosis in case of NS is currently the most optimal method of phlebohypertension correction in the LRV system preventing the development of NS severe complications such as LRV aneurysm, left gonadal vein (LGV) thrombosis and decompensated forms of pelvic congestion syndrome [3].

Aim

The aim was to assess long-term outcomes of the left renal vein reimplantation in case of nutcracker syndrome.

Materials and methods

The study included 56 patients (37 were males and 19 were females, the mean age was 28.24 ± 2.74) with critical

Table 1. LRV Doppler ultrasound parameters of the patients before and after RLRV, mean values, Wilcoxon W-test

Parameter	Patients with critical LRV stenosis before the surgery (n = 10), M ± m	Patients with critical LRV stenosis after RLRV (n = 8), M ± m	Wilcoxon W-test
Diameter, mm			
Renal hilum	13.40 ± 1.96	10.20 ± 1.08	p = 0.0117
Aorto-mesenteric segment	1.90 ± 0.87	7.50 ± 0.76	p = 0.0123
Peak blood flow velocity, cm/sec			
Renal hilum	27.40 ± 0.78	24.50 ± 0.98	p = 0.0077
Aorto-mesenteric segment	187.30 ± 2.95	38.70 ± 0.76	p = 0.0178

Table 2. LGV Doppler ultrasound parameters and the presence of pathological reflux in it in the patients before and after RLRV, mean values, Wilcoxon W-test

Parameter	Patients with critical LRV stenosis before the surgery (n = 10), M ± m	Patients with critical LRV stenosis after RLRV (n = 8), M ± m	Wilcoxon W-test
LGV diameter, mm	6.60 ± 1.30	4.20 ± 0.84	p = 0.0118
Presence of pathological refluxes in GV	+2 / +3	No pathological refluxes	

Table 3. LK Doppler ultrasound parameters in the patients before and after RLRV, mean values, Wilcoxon W-test

Parameter	Patients with critical LRV stenosis before the surgery (n = 10), M ± m	Patients with critical LRV stenosis after RLRV (n = 8), M ± m	Wilcoxon W-test
An increase in LK parenchymal thickness in comparison with the right one, cm	2.20 ± 0.46	1.60 ± 0.54	p = 0.0123
Signs of venous stasis of the LK	present	absent	

stenosis of the left renal vein who underwent RLRV from May 1999 to August 2023.

10 patients (9 males and 1 female, mean age 29.42 ± 0.78 years) were operated on between 1999 and 2013, that provided an opportunity to study long-term outcomes in the period from 7 to 21 years (a retrospective part). 46 patients (28 males and 18 females, mean age 23.65 ± 1.87 years) underwent the surgery between 2018 and 2023 (a prospective part). All the patients were assigned for follow-up examinations, which included a survey, objective status and Doppler ultrasound of the reconstruction site, LRV, LGV and the left kidney (LK) of patients.

Comparison of mean values between the groups of patients was performed using the non-parametric Mann–Whitney U-test. Wilcoxon W-test was used to compare the mean values before and after the treatment. Spearman's rank correlation coefficient (Rs) was calculated to determine the correlation between variables.

Results

8 patients of the retrospective part were examined at hospital visits, and 2 others were interviewed by telephone. All interviewed patients reported a gradual regression of clinical symptoms, namely, resolution of pain syndrome, hematuria, proteinuria, erectile dysfunction, dyspeptic phenomena. Objective findings: all the patients had no recurrence of varicocele. Ultrasound evaluation of LRV, LGV, LK parameters and comparison with preoperative indicators were performed, the data are presented in *Table 1*.

A statistically significant difference in the parameters between the two groups of patients ($p < 0.05$) has been found.

LGV ultrasound parameters and the presence of pathological refluxes in it were evaluated in the patients before and after RLRV, the data are presented in *Table 2*.

A statistically significant difference in the parameters of the patients before and after RLRV ($p < 0.05$) has been revealed.

The following LK ultrasound parameters were evaluated: size, thickness of parenchyma, signs of venous stasis.

According to the data in *Table 3*, reduced parenchymal thickness and no signs of LK venous stasis after RLRV were observed indicating elimination of phlebostasis in the LRV system.

A statistically significant difference in the indicators of the patients before and after RLRV ($p < 0.05$) has been found.

During ultrasound control of the reconstruction site, no stenosis was detected in 4 patients, non-critical stenosis of the reconstruction site (up to 50 %) was observed in 4 patients but without disturbances of venous outflow through the LRV, there was no difference in peak systolic velocity (PSV) in the LRV segments, pathological reflux and signs of LK venous stasis in the LGV were absent.

Long-term outcomes of treatment were studied in the period from 3 months to 5 years in the prospective part (46 patients). The mean age of individuals in this group was 24.00 ± 1.87 years.

The patients were recommended to undergo ultrasound control of the reconstruction site in 3, 6 and 12 months. The following parameters were evaluated: LRV diameter in the aorto-mesenteric segment and in the renal hilum, PSV of blood flow in these areas, differences in left and right kidney size, signs of LK venous stasis. Statistically significant differences were observed between all indicators in the patients before the surgical treatment and 3 months after RLRV ($p < 0.05$), except for the PSV indicator in the renal hilum ($p > 0.05$) *(Table 4)*.

All the patients from the prospective group as well as the retrospective group patients reported a gradual regression of clinical symptoms, namely, resolution of pain syndrome,

Table 4. Doppler ultrasound parameters of the LRV and LK in the patients before RLRV and in 3, 6 and 12 months after the surgery, mean values, Wilcoxon W-test

Parameter, units of measurement	Patients with critical LRV stenosis before the surgery (n = 46)	Patients with critical LRV stenosis 3 months after RLRV (n = 46)	Patients with critical LRV stenosis 6 months after RLRV (n = 46)	Patients with critical LRV stenosis 12 months after RLRV (n = 46)	Wilcoxon W-test*
LRV diameter in the aorto-mesenteric segment, mm	1.70 ± 0.64	7.50 ± 0.76	7.30 ± 0.38	7.10 ± 0.65	p = 0.0123
LRV diameter in the renal hilum, mm	15.20 ± 1.74	12.10 ± 1.04	10.80 ± 0.94	9.60 ± 0.52	p = 0.0242
PSV of blood flow in the aorto-mesenteric segment, cm/sec	192.20 ± 8.65	37.70 ± 1.56	35.90 ± 0.78	35.20 ± 0.68	p = 0.0117
PSV of blood flow in the renal hilum, cm/sec	29.50 ± 0.88	28.80 ± 1.24	27.50 ± 0.67	27.10 ± 0.46	p = 0.0872
An increase in the left renal parenchymal thickness in comparison with the right one, cm	2.30 ± 0.44	1.60 ± 0.32	1.60 ± 0.45	1.50 ± 0.62	p = 0.0123
Signs of venous stasis of the left kidney	present	absent	absent	absent	

*: differences between parameters before the surgery and in 3 months after RLRV.

hematuria, proteinuria, erectile dysfunction, dyspeptic phenomena and improvements in quality of life.

The average duration of observation period was 48.36 ± 16.48 months.

Discussion

RLRV was first performed by Stewart in 1982 and consisted in its disconnection from the inferior vena cava (IVC), the IVC defect suturing and reanastomosis below the SMA [4].

RLRV advantages included a short period of renal ischemia, but the risk of LRV thrombosis was among its disadvantages [5,6]. Analyzing RLRV cases, Hohenfellner et al. also stated that the intervention demonstrated the regression of symptoms in 7 out of 8 patients with NS under the observation for 41–136 months [7]. The authors also described an insignificant risk of postoperative complications, including deep vein thrombosis, extraperitoneal hematoma requiring surgical treatment, paralytic ileus that were treated with conservative methods, and mechanical intestinal obstruction that occurred four years after the LRV reimplantation [7].

At the same time, according to Hohenfellner, one patient had to undergo nephrectomy, despite the performed RLRV and elimination of phlebohypertension, due to continuous massive hematuria from renal and urethral varicose veins [7]. That could be explained by the vascular architecture adaptation to chronic phlebohypertension in the LRV system.

Open surgical correction of AMC has proven its effectiveness on the whole, and even though its use correlates with a number of complications, such as bleeding, thrombosis, intestinal paresis, today it remains the "gold standard" for the treatment of phlebohypertension in the LRV system and shows better long-term postoperative outcomes compared to other methods [8].

Endovascular treatment of NS was first mentioned by Neste et al. in 1996 [9]. The advantages of the method included minimal invasiveness and avoidance of general anesthesia.

The experience of Ananthan is interesting. He has analyzed 61 cases of endovascular LRV stenting retrospectively. The observation period was from 6 months to 6 years. Complete regression of clinical symptoms was observed in 59 patients. Complications such as stent migration, restenosis, venous occlusion, or stent fracture were rare [10]. Among 61 patients, 2 developed complications. One of the complications was stent protrusion into the LRV collateral, and the other was stent migration into the right atrium. Both complications were reversed by an open surgery [10].

Low molecular weight heparin for 3 days and switching to clopidogrel for 30 days and aspirin for 3 months were recommended after stenting [11].

However, some researchers indicated that not all patients had reduced pressure in the renal vein despite the correct stent placement in the narrowest segment of the renal vein [11,12]. The relative simplicity of the procedure and patient tolerance have resulted in widespread use of this technique.

A recently published study by Avgerinos ED included a retrospective analysis of 17 patients who underwent LRV stenting with a six-month follow-up period. All the patients reported resolution of left flank pain and hematuria. The stent migration into the inferior vena cava was observed in two cases. Restenosis requiring reintervention was noted in one patient [13].

Generally, most authors have leaned towards the opinion of good results after endovascular treatment in the first 3 months. At a later stage, this type of treatment should be selectively recommended due to the risk of complications (stent migration, embolism, fracture and stent protrusion) accounting for 8–10 % [11,14].

According to the latest consensus document on the management of vascular compression syndromes, endovascular treatment is unable to surpass the results of open surgery within a few years of surgical correction [15].

Conclusions

1. Based on the analysis of the RLRV long-term outcomes conducted in the period from 3 months to 21 years, all the patients reported gradual regression of clinical symptoms, namely, resolution of pain syndrome, hematuria, proteinuria, erectile dysfunction, dyspeptic phenomena.

2. Doppler ultrasound has shown a statistically significant increase in LRV diameter in the aorto-mesenteric segment from 1.90 ± 0.87 mm to 7.50 ± 0.76 mm (p = 0.0123) and a statistically significant decrease in PSV in this area from 187.30 ± 2.95 cm/sec to 38.70 ± 0.76 cm/sec (p = 0.0178) after the RLRV.

3. A statistically significant decrease in the diameter of LGV from 6.60 ± 1.30 mm to 4.20 ± 0.84 mm (p = 0.0118) and a decrease in LK parenchymal thickness from 2.20 ± 0.46 mm to 1.60 ± 0.54 mm (p = 0.0123) has been noted after RLRV.

Conflicts of interest: authors have no conflict of interest to declare.
Конфлікт інтересів: відсутній.

Надійшла до редакції / Received: 11.03.2024
Після доопрацювання / Revised: 29.03.2024
Схвалено до друку / Accepted: 10.04.2024

Information about the authors:
Kobza I. I., MD, PhD, DSc, Professor, Head of the Department of Surgery No. 2, Danylo Halytsky Lviv National Medical University, Ukraine.
ORCID ID: 0000-0001-8493-414X
Nesterenko I. R., MD, PhD, Assistant of the Department of General and Vascular Surgery, Ivano-Frankivsk National Medical University, Ukraine.
ORCID ID: 0000-0002-8358-291X

Відомості про авторів:
Кобза І. І., д-р мед. наук, професор, зав. каф. хірургії № 2, Львівський національний медичний університет імені Данила Галицького, Україна.
Нестеренко І. Р., д-р філософії, асистент каф. загальної та судинної хірургії, Івано-Франківський національний медичний університет, Україна.

References

1. Nastasi DR, Fraser AR, Williams AB, Bhamidi V. A systematic review on nutcracker syndrome and proposed diagnostic algorithm. J Vasc Surg Venous Lymphat Disord. 2022;10(6):1410-6. doi: 10.1016/j.jvsv.2022.08.003
2. Nesterenko IR. Treatment of aorta mesenteric compression: current problems and prospects. Art of Medicine. 2021;(3):36-42. doi: 10.21802/artm.2021.3.19.36
3. Duncan AA. How I treat nutcracker syndrome. J Vasc Surg Cases Innov Tech. 2023;9(4):101344. doi: 10.1016/j.jvscit.2023.101344
4. Charondo LD, Hamouche F, Stoller M. The Journey and Barriers to Treatment of Patients With Renal Nutcracker Syndrome. Urology. 2022;169:250-5. doi: 10.1016/j.urology.2022.08.013
5. St Hilaire C, Paisley M, Greene J, Casey KM. Left renal vein transposition for posterior Nutcracker syndrome. J Vasc Surg Cases Innov Tech. 2021;7(2):243-6. doi: 10.1016/j.jvscit.2021.02.016
6. Fitzpatrick S, Dunlap E, Schweitzer E, Phelan M, Nagarsheth K. Surgical treatment of nutcracker syndrome results in improved pain and quality of life. J Vasc Nurs. 2023;41(4):235-9. doi: 10.1016/j.jvn.2023.10.001
7. Sarikaya S, Altas O, Ozgur MM, Hancer H, Yilmaz F, Karagoz A, et al. Treatment of Nutcracker Syndrome with Left Renal Vein Transposition and Endovascular Stenting. Ann Vasc Surg. 2024;102:110-20. doi: 10.1016/j.avsg.2023.11.036
8. Franco-Mesa C, Gloviczki P, Erben Y. Nutcracker syndrome. J Cardiovasc Surg (Torino). 2021;62(5):467-71. doi: 10.23736/S0021-9509.21.11923-8
9. Rista E, Llambro M, Lazaj J, Aliu D, Saliaj K. Endovascular treatment of nutcracker syndrome. Kidney Int. 2022;102(4):942. doi: 10.1016/j.kint.2022.04.038
10. Kolber MK, Cui Z, Chen CK, Habibollahi P, Kalva SP. Nutcracker syndrome: diagnosis and therapy. Cardiovasc Diagn Ther. 2021;11(5):1140-9. doi: 10.21037/cdt-20-160
11. Fuentes-Perez A, Bush RL, Kalra M, Shortell C, Gloviczki P, Brigham TJ, et al. Systematic review of endovascular versus laparoscopic extravascular stenting for treatment of nutcracker syndrome. J Vasc Surg Venous Lymphat Disord. 2023;11(2):433-41. doi: 10.1016/j.jvsv.2022.10.001
12. Cronan JC, Hawkins CM, Kennedy SS, Marshall KW, Rostad BS, Gill AE. Endovascular management of nutcracker syndrome in an adolescent patient population. Pediatr Radiol. 2021;51(8):1487-96. doi: 10.1007/s00247-021-04986-0
13. Avgerinos ED, Saadeddin Z, Humar R, Salem K, Singh M, Hager E, et al. Outcomes of left renal vein stenting in patients with nutcracker syndrome. J Vasc Surg Venous Lymphat Disord. 2019;7(6):853-9. doi: 10.1016/j.jvsv.2019.06.016
14. Maharaj D, Mohammed SR, Caesar K, Dindyal S. Nutcracker syndrome: a case-based review. Ann R Coll Surg Engl. 2023 Dec 1. doi: 10.1308/rcsann.2023.0090
15. D'Oria M, Zlatanovic P, Anthony A, Dua A, Flores AM, Tanious A, et al. International Union of Angiology consensus document on vascular compression syndromes. Int Angiol. 2023;42(4): 282-309. doi: 10.23736/S0392-9590.23.05100-3