The nutcracker syndrome: Its role in the pelvic venous disorders

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Background: **Symptoms of pelvic venous congestion (chronic pelvic pain, dyspareunia, dysuria, and dysmenorrhea) have been attributed to massive gonadal reflux. However, obstruction of the gonadal outflow may produce similar symptoms. Mesoaortic compression of the left renal vein (nutcracker syndrome) produces both obstruction and reflux, resulting in symptoms of pelvic congestion. We describe the diagnosis and management of nine patients studied in our institutions.**

Materials and Methods: **From a group of 51 female patients with pelvic congestion symptoms studied at our institutions, there were nine patients with symptoms of pelvic congestion, microscopic hematuria, and left-sided flank pain. The diagnosis of the nutcracker syndrome was suspected based on clinical examination, Doppler scan, duplex ultrasound scan, computed tomography scan, and magnetic resonance imaging. The diagnosis was confirmed by retrograde cine-video-angiography with renocaval gradient determination and catheterization of both internal iliac venous systems. All patients had a renocaval pressure gradient >4 mm Hg (normal, 0-1 mm Hg). Renal compression was relieved by external stent (ES) in two patients, internal stent (IS) in one patient, and gonadocaval bypass (GCB) in three. GCB was preceded by coil embolization of internal iliac vein tributaries connecting with lower-extremity varicose veins in three patients. Three patients deferred surgery and are under observation. Mean follow-up time was 36 months (range, 12-72 months).**

Results: **Hematuria disappeared postoperatively in all patients. ES and IS normalized the renocaval gradient and resulted in significant alleviation of symptoms (90% improvement on a scale of 0-10 where 0 = no improvement and 10 = greatest improvement). Two patients with GCB had a residual gradient of 3 mm Hg. The third patient normalized the gradient. In this group, improvement of symptoms was 60%. Patients awaiting surgery are being treated conservatively (elastic stockings, hormones, and pelvic compression). They have shown only moderate improvement.**

Conclusion: **The nutcracker syndrome should be considered in women with symptoms of pelvic venous congestion and hematuria. The diagnosis is suspected by compression of the left renal vein on magnetic resonance imaging or computed tomography scan and confirmed by retrograde cine-video-angiography with determination of the renocaval gradient. Internal and external renal stenting as well as gonadocaval bypass are effective methods of treatment of the nutcracker syndrome. IS and ES were accompanied by better results than GCB. Surgical and radiologic interventional methods should be guided by the clinical, radiologic, and hemodynamic findings. (J Vasc Surg 2001;34:812-9.)**

Compression of the left renal vein between the abdominal aorta and the superior mesenteric artery (SMA) was first described in 1950 by El Sadr and Mina.[1] Chait described the aorta and the SMA as two arms of a "nutcracker" that can potentially compress the left renal vein.[2] This vivid description prompted the Belgian physician de Schepper[3] to name this phenomenon the "nutcracker syndrome". This syndrome produces symptoms of pelvic congestion, which include dysmenorrhea, dysuria, dyspareunia, vulvar and pelvic varices in the female, and varicocele in the male.[4] Varicose veins of the lower extremities are frequently observed. An important finding is the presence of microscopic hematuria, which on occasion may become severe[5-7] and constitute the main reason for seeking consultation with a urologist.[8-14] In this article, we present our experience in the diagnosis and treatment of nine patients with this condition.

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MATERIALS AND METHODS

From a series of 51 patients with symptoms of pelvic congestion studied at our institutions, we recognized during the last 6 years (January 1994-January 2000) nine patients with symptoms of pelvic congestion, hematuria, and left-flank pain radiating to the buttock. Mean age of the patients was 35.5 years (range, 28-46 years). The mean number of term pregnancies was 3.1 (range, 1-5). Mean follow-up time was 36 months (range, 12-72 months).

Two patients had gluteal varices localized to the left side and underwent varicography to investigate its intrapelvic connections. There were four patients with varicose veins of

the lower extremities. Two of them had greater saphenous incompetence in addition to varicosities on the posteromedial aspect of the left thigh. Two other patients had competent saphenous systems.

The diagnosis of the nutcracker syndrome was suspected clinically and by laboratory analysis. Doppler scan with the patient in the upright position was performed using a 9-MHz bidirectional Doppler probe placed directly over the mass of dilated vulvar varices. A loud venous reflux during Valsalva maneuver was evidence of pelvic venous reflux. Pelvic ultrasound scan revealed predominantly distended varicose veins in the pelvis, but in our hands, this method has not been useful to guide our therapeutic approach. Computed tomography (CT) scan was performed in four patients, magnetic resonance imaging (MRI) in two patients, and both imaging procedures were performed in three patients. In all patients, CT and/or MRI demonstrated compression of the left renal vein between the aorta and the SMA, suggesting the nutcracker syndrome (Fig 1). Compression was confirmed by retrograde phlebography and cine-video-angiography. In addition to the nine patients with the nutcracker syndrome, this procedure was performed in 27 other patients with severe symptoms of pelvic congestion and evidence of pelvic reflux. We used the Seldinger technique through the common femoral vein. The catheter was advanced to the left renal vein and the left ovarian vein was selectively catheterized at its junction with the renal vein. At this time, renocaval gradient was determined in the supine and prone positions. Once the ovarian vein was catheterized, a nonionic low-osmolality contrast dye was injected after tilting the patient into a semierect position. The patient must remain in this position until the pelvic veins are visualized. Cine-video-angiography allows visualization of the point of compression of the left renal vein at the mesoaortic crossing (Fig 2, *A*), demonstrating the presence of perirenal varicosities and stagnation of the contrast material in the renal vein. In addition, filling of the pelvic veins, vulvar varices, and occasionally even the lower-extremity varicosities (Fig 2, *B*) can be readily observed.

Renal compression was relieved by external stent (ES) in two patients. A 20-mm–diameter 50-mm–long polytetrafluorethylene (PTFE) ring reinforced graft was wrapped around the left renal vein at the site of compression between the SMA and the aorta as described by Barnes.[15] In one patient this procedure was done through the laparoscopic approach, and in the other, through a midline laparotomy. One patient received a 60-mm Palmaz balloon internal stent (IS) (Johnson & Johnson, Providence, RI) in the left renal vein. In three patients, coil embolization of the internal iliac vein tributaries (internal pudendal and obturator veins) refluxing into vulvar varices and lower-extremity varicosities was performed during retrograde cine-video-angiography after determination of the renocaval gradient. Gonadocaval bypass (GCB) was performed in these patients 48 to 72 hours after the procedure. A 15-mm diameter Dacron graft was inserted between the left gonadal vein and the inferior

Fig 1. MRI demonstrating compression of the left renal vein between the SMA and the aorta (nutcracker syndrome). Dilatation of the left renal vein and perirenal varicosities is clearly observed.

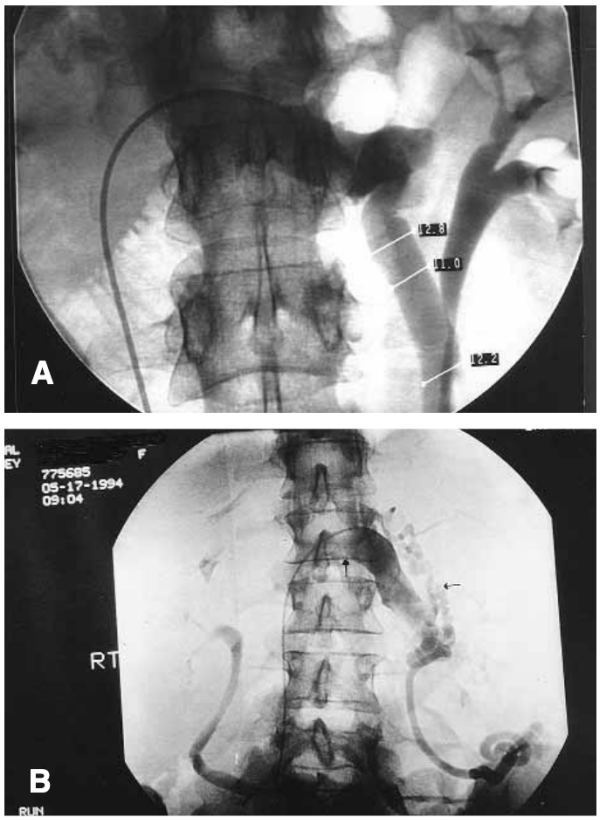

Fig 2. Retrograde catheterization of left renal and gonadal veins. **A,** The left renal vein shows the point of compression of the SMA and a very large left gonadal vein (normal, 3-4 mm diameter). **B,** Nutcracker syndrome. Retrograde catheterization of the left renal vein shows mesoaortic compression (*vertical arrow*), of the left renal vein and perirenal varicosities (*horizontal arrow*). Obstruction of the gonadal outflow is evident. Kinking and curls of the gonadal vein are the radiographic manifestations of obstruction. Patient had left-flank pain and hematuria.

Clinical, diagnostic, and treatment characteristics of nine patients treated for mesoaortic compression (nutcracker syndrome)

Age (y)	*PCS*	*Physical examination*	*Microscopic hematuria*	*Radiologic imaging*	*RCVA*	*RCG preop (mm Hg)*	*Treatment*	*RCG postop (mm Hg)*	*Follow-up (mo)*	*Improvement scale*
35	Yes	Gluteal varices left	Yes	MRI	Yes	14	ES	0	72	9
39	Yes	Varices right lower extremity	Yes	CT	Yes	6	ES	1	60	9
40	Yes	Vulvar varices	Yes	MRI and CT	Yes	6	IS	1	24	8.5
32	Yes	Varices right lower extremity	Yes	CT	Yes	5	GCB	2	16	6
29	Yes	Bilateral varicose veins	Yes	CT	Yes	7	GCB	3	12	5
46	Yes	Gluteal varices	Yes	MRI and CT	Yes	4	GCB	3	28	6
37	Yes	Varices left lower extremity	Yes	MRI and CT	Yes	5	OBS	NA	36	5
34	Yes	Vulvar varices	Yes	CT	Yes	6	OBS	NA	14	5
28	Yes	Vulvar varices	Yes	MRI	Yes	7	OBS	NA	18	5

PCS, Pelvic congestion symptoms (dysmenorrhea, dyspareunia, dysuria, pelvic pain); *RCVA*, retrograde cine-video-angiography; *RCG*, renocaval gradient; *preop*, preoperatively; *postop*, postoperatively; *OBS*, observation.

vena cava. Three patients deferred surgical intervention and are under observation. All patients with stents and GCB were placed on long-term antiplatelet drugs.

The patients are followed-up with a questionnaire in which they describe the presence or absence of hematuria, dysmenorrhea, dyspareunia, and dysuria. Improvement of pelvic pain is graded on a scale of 0 to 10, where 0 = no improvement (worst pain) and 10 = greatest improvement (no pain).

RESULTS

Our results are summarized in the Table. Renocaval gradient determination was done in all patients with severe symptoms of pelvic congestion and gonadal reflux. All patients with the nutcracker syndrome had an elevated renocaval gradient (range, 4-14 mm Hg). The gradient in patients with predominantly gonadal reflux was normal. In all patients undergoing surgical treatment, hematuria disappeared postoperatively. The three patients with deferred surgical treatment continue with mild hematuria and symptoms that are not considered severe enough to warrant surgical treatment. The renocaval gradient normalized in the patients who had both ES and IS procedures. Pelvic pain in these patients was significantly alleviated (90% improvement on a scale of 0-10 where 0 = no improvement and 10 = greatest improvement).

The MRI performed 1 week after surgery in one patient (external reinforced PTFE stent) revealed partial thrombosis of the left renal vein (Fig 3). The patient was placed on anticoagulants, and a control MRI 6 months later showed recanalization of the left renal vein. The patient is asymptomatic at 72 months' follow-up.

In two patients with GCB, there was a residual gradient of 3 mm Hg. The third GCB patient normalized the gradient. In this group, improvement of the symptoms was 60% with the exception of dyspareunia, which improved in only 3 out of 6 surgically treated patients.

Three patients were managed with conservative measures consisting of elastic stockings, hormones, and pelvic compression. They have shown only moderate improvement.

DISCUSSION

Compression of the left iliac vein by the right iliac artery (Cockett or May-Thurner syndromes)[16,17] is well recognized, and there are many reports in the literature on its surgical[18] and endovascular treatment.[19-28] In this syndrome, findings of spurs, thickening, and membranes at the site of compression have been described. Compression of the left renal vein between the SMA and the aorta was first described by El Sadr and Mina,[1] but it was De Shepper's[3] publication in which the term "nutcracker syndrome" was introduced in the literature. In 34 human cadaver specimens of the mesoaortic region dissected in the anatomy laboratory of the Uniformed Services University of the Health Sciences, we found histologic changes in the wall of the renal vein in 13 specimens. The changes were similar to those described in the Cockett syndrome (Fig 4).[29,30] De Shepper[3] described two cases in which outflow obstruction of the left renal vein caused by compression between the aorta and the SMA resulted in the development of extensive perirenal and pararenal varicosities. This plexus of abnormal hypertensive veins is likely responsible for the important symptom of hematuria.[5-14] Other clinical manifestations of this syndrome have been reported in the literature. Chronic pediatric fatigue syndrome[29] and gastrointestinal symptoms[30] have been attributed to the nutcracker syndrome. These cases are rare, and it is not clear whether the nutcracker syndrome is really the etiology.

In 1974, Pastershank[31] reported the first case of surgical treatment of a patient with the nutcracker syndrome in English literature. A 30-year old male patient presented with hematuria and left-flank pain that was aggravated by exercise. A fibrous tunnel between the aorta and the mesenteric artery was divided and the left renal vein freed. The patient was asymptomatic during a follow-up period of 2 years.

A landmark contribution to the knowledge of this syndrome was Beinart et al's publication.[32] In a group of 50 apparently healthy persons, they found that the renocaval pullback mean gradient ranged from 0 to 1 mm Hg. An

Fig 3. One-week postoperative MRI of ES in a case of nutcracker syndrome. Externally reinforced PTFE stent is clearly visible. Partial thrombosis of the left renal vein was observed. The patient was treated with anticoagulants. Six months later, the renal vein had recanalized and the patient's symptoms had greatly improved.

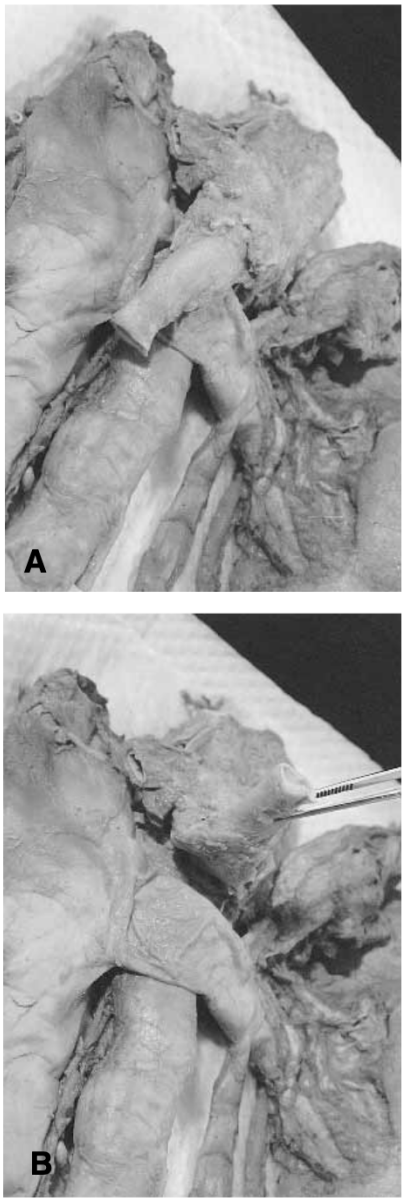

Fig 4. Human cadaver specimens. **A,** SMA compressing the left renal vein against the aorta. **B,** Lifting the SMA reveals a flattened left renal vein. This compression produced changes in the renal vein wall similar to those described in the Cockett syndrome.

elevated gradient between the left renal vein and the vena cava can therefore be used as a valid criterion to diagnose the nutcracker syndrome. In our series, all patients showed a significantly elevated gradient. The elevated renal venous pressure is responsible for the patient's hematuria and the main reason for the patient to consult an urologist. Hematuria, however, is not always present.[33]

The first patients reported in the literature were male and presented with varicocele, pelvic pain, and hematuria. Zerhouni et al[4] made a landmark contribution in the understanding and diagnosis of the nutcracker syndrome with their publication of 1979. They observed an elevated left renal vein pressure in three patients with left-sided varicocele and pelvic pain. The right side was normal. Left renal vein pressure was normal in a control group. Because of the frequent presence of vulvar and lower-extremity varicosities and our interest in the venous pathology, in our institutions we have studied mostly female patients. Women often suffer severe and incapacitating clinical manifestations.[34,35]

It must be emphasized that the primary diagnostic tool should be the clinical examination. If a patient has symptoms of pelvic congestion and hematuria, the association of left-sided flank pain with radiation to the gluteal area, pelvic discomfort, and pelvic varices in the female and varicocele in the male, constitute a strong basis for the diagnosis. Contrast MRI or CT scan should be the next diagnostic step. Both can clearly visualize the compression of the left renal vein between the aorta and the SMA, as well as distention of the left renal vein and evidence of left kidney congestion (Fig 1).

However, this observation does not prove the existence of hemodynamic significance. The definitive documentation of the nutcracker syndrome should be the retrograde renocaval gradient determination and the contrast visualization of the gonadal system and its pelvic and extrapelvic connections. In our institutions, patients with the clinical and radiologic diagnosis of the nutcracker syndrome were studied in both the supine and prone positions. Placing the patient in the prone position theoretically decreases the renocaval gradient, displacing forward the SMA with the intestinal mass. We documented changes in pressure with decrease of the gradient in the prone position in only two patients. Zerhouni et al[4] reported no pressure changes in a patient examined in the prone and supine positions. There are

recent reports of the usefulness of determination of peak velocities in the left renal vein determined by Doppler ultrasound scan in the diagnosis of the nutcracker syndrome.[36] This method may prove valuable in the noninvasive diagnosis of the nutcracker syndrome. However, further experience with this diagnostic modality is necessary before we can establish its definitive role.

There has been a number of surgical procedures described to alleviate the renal vein compression. A PTFE ring reinforced ES can be wrapped around the renal vein[15] between the aorta and the SMA to prevent its compression by the mesoaortic clamp. This procedure was performed in two of our patients. In one of them, the operation was done by the transperitoneal route, and in the other, by laparoscopic surgery. Both procedures normalized the renocaval gradient postoperatively. A third patient had a 60-mm Palmaz balloon-expandable intraluminal stent. The stent was placed in the renal vein at the level of the mesoaortic compression. The gradient was immediately corrected. Other investigators had similar results with this technique.[36] The use of stents in the venous system to correct stenotic segments as observed in the Cockett,[19-28] superior vena cava,[37] thoracic outlet,[38] and Budd Chiari syndromes has been described in the medical literature. Excellent results have been reported with the use of stents in the treatment of venous stenosis in patients undergoing hemodialysis.[39-41] Reports of the use of expandable metallic stents in the treatment of the nutcracker phenomena are scarce. The placement of an expandable metallic stent in the renal vein for the nutcracker phenomena was first described by Neste et al.[42] Segawa et al[43] reported the use of an endovascular metallic stent in the renal vein to treat a patient with nutcracker phenomenon and severe hematuria. This author placed a 7-cm–long and 20-mm–diameter metallic stent at the place of the mesoaortic compression. The stent was covered with a thin layer of PTFE. The renocaval gradient disappeared, and the patient's symptoms of severe anemia improved dramatically. The patient continued with mild hematuria, but her hematocrit improved considerably. Park et al[36] from South Korea reported a case of a 47-year old man with left varicocele operated on 7 years before with findings of microscopic hematuria, left renal hypertrophy, and arterial hypertension. The diagnosis in this case was performed by Duplex ultrasound scan velocity flow analysis. A gradient of 3 mm Hg between the left renal vein and the inferior vena cava was determined. These authors inserted an 18-mm diameter Niki stent. The patient's symptoms improved with relief of the hematuria and arterial hypertension. Even though endovascular stenting is an attractive and relatively simple option, its future in the venous system is still uncertain. As has been the case in the large experience with stenting in the arterial system, a long-term problem is the fibromuscular hyperplasia, which leads to vascular occlusion. The venous system is particularly prone to this phenomenon. Another reported complication of internal stenting is proximal embolization. Endovenous devices such as the inferior vena cava filter are prone to this serious complication. Caution must be taken in being too optimistic about the long-term results of stents in the nutcracker syndrome because there are no follow-up periods longer than 2 years reported in the literature. However, in light of the advances of the endoscopic technology, external stenting with reinforced PTFE via the endoscopic approach should be the preferred technique. In our opinion, currently this is the technique of choice. Other methods of treatment of the nutcracker phenomenon have been reimplantation of the renal vein,[44] renal autotransplantation,[45] and other radical procedures.[46,47] A gonadocaval bypass serves both as an outflow for the obstruction of the gonadal system and as an accessory drainage pathway for the renal vein. This type of approach has been used successfully in mesocaval anastomosis (H graft) for the treatment of portal hypertension. In our patients, the graft was a 15-mm–diameter Dacron segment. There was a residual gradient of 3 mm Hg in these patients. This may be explained by the complex hemodynamics of the gonadal and renal venous outflow. Turbulence at the confluence of the gonadal with the obstructed renal flow may at least partially explain the residual gradient. Another possible factor may be the anatomic configuration of the graft between the gonadal vein and the inferior vena cava. With the aorta in between, the graft must have a curve, which may impair the low-pressure blood flow between the cava and the gonadal veins.

Because of severe reflux of the gonadal system, coil embolization of the intra-extrapelvic venous connections was performed before surgery for varicose veins of the extremities in some of our patients. This procedure is recommended to prevent recurrence of lower-extremity varicose veins in all patients with documented pelvic venous reflux and has replaced the extraperitoneal surgical division of the refluxing pelvic veins connecting with extrapelvic varices, which we performed early in our experience.[48]

Three patients with the diagnosis of nutcracker syndrome confirmed by retrograde renocaval gradient determination are under observation. Interventional treatment was deferred, and they are managed by conservative measures, such as elastic stockings, hormones, and pelvic elastic compression. They have shown only moderate improvement.

In conclusion, the diagnosis of the nutcracker syndrome should be considered on the basis of a careful clinical examination in patients with left-flank pain with radiation to the left buttock, symptoms of pelvic congestion, and hematuria. Compression of the left renal vein between the SMA and the aorta observed in the CT scan and/or MRI should alert the physician to consider the diagnosis. If the symptoms merit, retrograde cine-videoangiography with pullback determination of renocaval gradient is the definitive diagnostic test and should be performed in all of these patients. The gradient is an important parameter to document the severity of the obstruction and monitor the therapeutic results. Internal and external renal stenting, as well as gonadocaval bypass,

are effective methods of treatment of the nutcracker syndrome. External stenting is accompanied by better results than other nonstenting procedures, but longer observation periods are needed. Patients should be placed on a long-term antiplatelet medication. Indications for surgical and radiologic interventional methods should be guided by the clinical and noninvasive examinations.

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DISCUSSION

Dr Anthony Comerota (Philadelphia, Penn). Good morning, ladies and gentlemen, comoderators. I would like to commend Dr Scultetus for her very lucid presentation, and I thank her and Dr Villavicencio for an advanced copy of the manuscript for my review. I do recommend this manuscript to all of you as it is an excellent summary of their experience with renal vein compression between the aorta and the superior mesenteric artery, which is termed the "nutcracker syndrome." The figures that they include are clearly descriptive of the problem, and the pathophysiology is nicely defined. Their series consists of nine female patients, all of whom had pelvic congestion symptoms, varices, and microscopic hematuria. All of their patients had MRI and CT scan evidence of renal vein compression, and all of their patients underwent retrograde cine-video-angiography with renal vein vena caval pressure gradients measured. Those pressure gradients ranged from 5 mm Hg to 14 mm Hg.

I have several questions for the authors. It seems that the MRI or CT scans are diagnostic or at least are very good screening tools. If a patient with these symptoms has a normal CT scan, can we exclude the diagnosis? Can we substitute an alternative noninvasive finding for a CT scan or an MRI, such as a renal vein duplex? Can the size of the distal renal vein as it emerges from the renal pelvis measured by duplex be indicative of the diagnosis of nutcracker syndrome?

The gonadocaval bypass patients had essentially the same outcome based upon your follow-up improvement scale as the patients that you labeled "observation." Have you abandoned the gonadocaval bypass, and if you have not, which patients would you select for that procedure in the future?

Do you use the renal caval pressure gradients as a guide to the timing of the procedure that you would offer or the type of procedure that you would offer?

I was impressed that in your population there were all females and I would have anticipated that from your institution you would have at least included a couple males in your patient population.

Perhaps you can give us the benefit of your experience in assisting our approach to such a patient. What is your initial approach? When do you move from nonoperative intervention to operative intervention, and what type of intervention do you now recommend?

Thank you for the opportunity to discuss this fine paper.

Dr Anke H. Scultetus. Thank you, Dr Comerota. It is an honor that you have discussed my paper. Your questions give me the opportunity to get into more detail about some very important issues.

The MRI or CT scan has proven to be a valuable noninvasive method in the diagnosis of the nutcracker syndrome. The compression of the left renal vein between the superior mesenteric artery and the aorta was clearly visible in all of our patients. However, this does not signify hemodynamic significance. If a patient has a normal CT scan, we cannot exclude the diagnosis. If the patient has severe symptoms, we always perform cine-video angiography with determination of the pullback gradient to confirm the diagnosis and to evaluate the hemodynamic significance of the compression of the LRV. In our hands, MRI or CT scan were the noninvasive methods of choice to screen a suspected nutcracker diagnosis. We know that other institutions use duplex scan successfully. If you have an experienced technician, this technique may be a valuable screening method for the nutcracker syndrome. In our experience, this was not a useful method and we did not use it enough to make general statements about its benefit.

The patients undergoing gonadocaval bypass did not have similar improvement as the stented patients. In our opinion, the future in the surgical treatment of the nutcracker syndrome lies in the stenting procedures. However, GCB may be justified in patients with a high pressure gradient (>10 mm Hg).

We did not use the renocaval pressure gradient as a guide to timing the procedure. The decision of surgical intervention is the patient's decision. It entirely depends on how severe the patient's symptoms are and how much they impair their lifestyle. In the diagnosis of the nutcracker syndrome, you have to listen carefully to the patient's clinical history. The patient will guide you to the diagnosis. The decision for surgery will be made by the patient based on your advice as a physician. We have three patients that deferred surgical intervention. They felt that even though their symptoms bothered them, they were not severe enough to warrant surgery.

Thank you for addressing the subject of the male patient, Dr Comerota. The nutcracker syndrome also exists in the male patient. The first reports in the literature on this syndrome were actually about male patients. Varicocele, left-flank pain, and hematuria are the most prominent symptoms in the male, but they do not appear to be as severe as the symptoms in the female patient. They usually seek consultation with the urologist, and we do not see them often. The presence of vulvar varices in addition to symptoms of pelvic congestion has led the referring physician to seek vascular consultation in our service.

In response to your last question, I want to briefly summarize our work-up in patients that come to our clinic with hematuria and signs of pelvic congestion. The first and most important diagnostic step is a careful clinical history. If the patient complains of left-sided flank pain, hematuria, dysuria, dysmenorrhea, and dyspareunia, you may suspect the nutcracker syndrome. Vulvar and gluteal varices are another hint. You then perform an MRI or a CT scan. These studies may clearly show the compression of the LRV between the SMA and the aorta. Hemodynamic significance of the compression is confirmed by cine-video angiography and determination of the renocaval gradient. Surgical treatment is indicated when the patient feels that the symptoms are severe enough. The most effective method in our opinion is external stenting via the laparoscopic approach. However, we need to be careful in being too optimistic about this procedure, since the follow-up period with this method has not been long enough to establish its firm role in the treatment.

Dr B. B. Lee (Seoul, South Korea). I very much enjoyed your presentation. In our experience of the internal stent on the renal

vein problems, 4 years later both cases we performed developed hemodynamically significant stenosis again. So both cases ended up having acute transplantation. I would rather like to suggest that if there is any situation like this with a significant problem with the renal vein system, autotransplantation to the iliac vessel might be the quickest and safest thing to do. Any kidney transplant surgeon can do it within 2 hours.

Dr Scultetus. Thank you for your comment, Dr Lee. As I said, the experience with stenting in the nutcracker syndrome is just beginning, and we need to be cautious in our optimism. The excellent results with stenting for the Cockett syndrome lead us to believe that this method could also be valuable in treatment of the nutcracker syndrome. The risk of stenosis is also present in renal autotransplantation. Our stented patients are on antiplatelet therapy for longer than 6 months, and so far we do not observe restenosis.

Dr Robert Rutherford (Silverthorne, Colo). I have just one question that occurred to me. In some complex aortic aneurysm surgery, we often ligate the left renal vein medially, leaving the collaterals, and very rarely is there any indication for reconstructing the vein and rarely do we have any such consequences. Is there something special about the anatomy of these patients, or is it something to do with partial intermittent occlusion that gives them their symptoms? Do you have any feeling for that after going through the literature on this?

Dr Scultetus. Thank you, Dr Rutherford, for this comment. As it is the case in varicose veins of the extremities, we believe that the nutcracker syndrome with its obstruction to the gonadal flow becomes symptomatic in patients that have a genetic predisposition to a venous wall weakness. In 34 human cadaver dissections of the mesoaortic region performed at our university, we found histologic changes in the renal vein wall at the site of compression by the superior mesenteric artery in 38% (13 specimens), but we do not have a 38% prevalence of nutcracker syndrome in the population. We believe that chronic compression of the outflow of the renal vein develops a pattern of collateral circulation different than its acute surgical obstruction. In the former, there are abundant pelvic crossover collaterals and pathological dilatation of the gonadal vein tributaries in which genetics plays an important role. These factors may contribute at least partially to explain the symptomatology of the nutcracker syndrome.

Dr Hugo Partsch (Vienna, Austria). Dr Scultetus, you showed us one slide with vulvar varices on the right side. Was it turned around?

Dr Scultetus. Your observation was very astute, Dr Partsch. No, this was not a mistake. The presence of gluteal varices on the right side demonstrates the numerous venous collaterals from the left to the right side of the pelvis. Because of these collaterals, patients with a left renal vein compression may have vulvar and gluteal varices on the right side as seen on the slide.

Dr Peter Gloviczki (Rochester, Minn). We had a small series at the Mayo Clinic, and we found that most of the patients were very thin, with lack of retroperitoneal and mesenteric fat. In three patients, we did distal transposition of the renal vein into the inferior vena cava, and that looks like a good operation. I know that there are several reports on cases of autotransplantation of the affected kidney into the pelvis with good clinical results too.

Unidentified speaker. Just one last comment. I think, to address Dr Rutherford's question, although we ligate the left renal vein with impunity for aortic reconstruction, they are mostly in postmenopausal women. This is a disease of young women who have venous reflux and so they are submitted to venous hypertension in the gonadal system.