Hypertension in children is often associated with impaired blood flow through the kidneys as a result of the strictures of main trunks of renal arteries. Kidney autotransplantation with kidney implantation into iliac vessels is a well-recognized treatment for hypertension and arterial nephropathy in children, especially in cases involving complex reconstruction of arteries, or the need of reimplantation of arteries outside the pathologically changed aorta.

**The aim of the study** was to compare a group of children operated using classic and modified kidney autotransplantation technique with rotation of the kidney by 180 degrees.

**Material and methods.** For the first time we performed such operation in 2001 in order to obtain favorable arrangement of anastomosed vessels and to avoid the need of shortening and anastomosing of the urether. In patients requiring reconstruction of arteries in the „back table” we usually used the classic method, but in cases with difficulty in matching short vessels, the modified technique was used even after “ex-situ” reconstructions.

The subject of the report are 11 children aged from 8 years to 17 years in which we performed a modified kidneys autotransplantation technique with its rotation. In retrospective analysis we observed: function of operated kidney, occurrence of postoperative complications, need for reoperations or other vascular or urological interventions, degree of normalization of blood pressure.

**Results.** During post operative observation we found no difference in the amount of vascular complications between the two groups. We observed difference in the occurrence of urological complications for the benefit of the group after the rotation of transplanted kidneys. At the same time using this method of operation, we obtained normalization of blood pressure and the possibility of significant reduction or discontinuation of pharmacological treatment. In all patients, we observe normal function of transplanted kidneys, except for one that was removed.

**Conclusions.** Modified method of kidney transplantation with rotation seems to be a good and effective method of treatment in cases of difficulties with vascular and urethral matching. It is safe, reducing urological complications, alternative for classical operations.

**Key words:** renovascular hypertension, renal autotransplantation, children
than in adults changes occur on both sides and affects intrarenal branches (5, 6, 7). In children coexistence of vascular anomalies in other organs is also more common (8). Excluding newborns and infants, in whom coarctation of the aorta is the leading cause of hypertension, renovascular hypertension is the most common, potentially curable cause of hypertension in children (9).

Surgical treatment of patients with RVH should be carefully and individually planned to the nature and extent of changes in renal arteries, and often also in aorta. Kidney autotransplantation with reimplantation into iliac vessels is a recognized treatment for hypertension and arterial nephropathy in children, especially in cases involving complex reconstruction of the arteries, or the need of artery reimplantation outside the pathologically changed aorta, such as in patients with narrowing of abdominal aorta (midaortic syndrome – MAS) (fig. 1). We want to present our modified method of kidney autotransplantation with its rotation by 180 degrees which may be helpful in overcoming technical problems with reimplantation of the kidney. The operation was performed for the first time in the Department of Pediatric Surgery and Organ Transplantation in 2001 in order to obtain favorable arrangement of anastomosed vessels and to avoid the need to shorten and anastomose the ureter.

In patients requiring reconstruction of arteries on the “back table” we usually used the classic method because of the need to cut of the ureter, but in cases with difficulty in matching short vessels, the modified technique was used as well after “ex-situ” reconstructions.

MATERIAL AND METHODS

Between the years 1994-2008 in the Department of Pediatric Surgery and Organ Transplantation we performed 39 primary operations in 29 patients as a treatment of renovascular hypertension, including two nephrectomies, 7 resections of artery stenoses, with reimplantation back to the aorta, 30 kidney autotransplantations into iliac vessels.

We report group of 11 children, including 6 girls and 5 boys, aged from 8 years to 17 years, (average 11.5 years), in which modified renal autotransplantation with its rotation by 180 degrees was performed. In 8 cases procedure was performed without cutting off the urether, and in 3 cases after cutting ureter and arterial reconstruction at the “back table”.

In 6 children renal artery stenosis was bilateral, in the remaining 5 – unilateral. In cases of bilateral stenosis, modified autotransplantation was performed on one side, while on the other side we performed classical autotransplantation in 4 children and artery reimplantation into the aorta in 2 children.

In 4 children „midaortic syndrome” was diagnosed, in 3 Recklinghausen disease, in 1 Allagille’s syndrome

Fig. 1. Classical autotransplantation technique (A); modified technique with 180 degree kidney rotation (B)
Surgical technique

Access was transperitoneal by median incision. After mobilizing the colon, kidney was exposed and mobilised, and renal vessels dissected, suspended and divided near to aorta and IVC, urether was usually not divided. Kidney was immediately perfused with cold Ringer’s solution with heparin through the renal artery. On the urether soft plastic clamp was set, to prevent backward filling with blood kidney’s vascular bed. Vascular reconstruction was carried out in situ, with kidney covered with ice bag. We always brought the vessels into the feasibility of single arterial and venal anastomoses. Then kidney was moved back to the iliac fossa at the operated side and turned upside down, while using excess length of the urether, to arrange so that it made a gentle arc turning 180 degrees without the deflection of the long axis. Urether was attached to the retroperitoneal tissue in 2-3 points, so that it did not have a tendency for sharp bends. Then renal vein was anastomosed end to side with a common iliac vein or IVC just above bifurcation with continuous Prolene 6/0 or 7/0 suture, and then renal artery with common iliac artery or aorta end to side with continuous Prolene 6/0 or 7/0 suture (fig. 1 and 2). If there was a need to make an ureteral anastomosis, we made it end to end with widening of the anastomosis by longitudinal incision of both ends on the opposite sides, using continuous PDS 7/0 suture and stented with „double J” cathether. Suction drain was always placed to the retroperitoneal cavity. In cases of bilateral pathology operation on both sided were performed with a break period of about 2 months (from 5.4 to 13 weeks, on average 7.2 weeks).

We retrospectively analyzed:
- function of operated kidneys
- blood biochemistry (urea, creatinine, GFR)
- renal scintigraphy
- renal vascular flow (doppler ultrasound)
- the occurrence of postoperative complications
  - vascular
  - urological
  - the other
- the need for reoperations or other vascular or urological interventions
- degree of normalization of blood pressure

RESULTS

Modified kidney autotransplantation (11 kidneys) accounted for 34% of all kidney autotransplantations performed in our center (32 autotransplantations, including 30 primary operations and 2 reoperations after local excision of stricture of renal artery and its reanastomosis to the aorta). Post operative

Fig. 2. Scheme of mounted kidney autotransplantation with 180 degree rotation

Fig. 3. Angiography of patient with „midaortic syndrom” – abdominal aorta and left renal artery stenosis. Patient after right kidney autotransplantation into right iliac fossa, before operation in the left side
observation time of this group of patients is from 10 months to 7 years, an average of 4 years.

Post operative function of operated kidneys

Normal kidney function was found in 10 out of 11 patients who underwent kidney autotransplantation with its rotation. In 1 patient we tried initially to reconstruct multiple strictures of branches of renal arteries, but because of the extension of vascular pathology we did not obtain a satisfactory kidney perfusion. Subsequently it was complicated by thrombosis, and finally we had to perform nephrectomy.

Participation in secretional activity of both kidneys in renal scintigraphy is within the range of 41-61%. All 11 patients had proper level of serum urea and creatinine [urea 10-34 mg / dl (avg.27.6 mg/dl), creatinine 0.4-0.8 mg/dL (avg.0.63 mg/dl)] (fig. 4).

Post operative doppler ultrasound, in both early and late postoperative period was a sensitive, noninvasive method for monitorig of operated kidneys. Besides 2 cases of postoperative vascular complications described below, there were no disruption in the flow in ultrasound examination in the other children after the modified autotransplantation.

The effectiveness of normalization of hypertension

In all patients blood pressure normalization was obtained (fig. 5)

In 7 children the amount of medications was significantly reduced (4 remains on one medicine), in 1 patient pharmacotherapy was totally discontinued. Three patients take the same amount of antihypertensive drugs as before the surgery, but their blood pressure is normalized (fig. 6). A total quantity of drugs taken by patients fell within the range between 2 and 6 medicines (an average of 3.6 drug/patient), before the surgery, to range between 0 and 4 medicines (an average of 1.7 drug/patient) after the surgery.

Post operative complications

In 7 patients there were no post operative complications. Two patients had vascular complications, there were no urological complications. In 3 patients complications of another kind occurred.
Vascular complications

Two patients required vascular reinterventions (18%). In 1 patient we successfully dilated an additional renal artery by transluminal balloon angioplasty. The patient after complex vascular reconstruction required reoperation because of artery thrombosis, and nephrectomy 10 days later because of a critical renal ischemia. In the whole group of patients with renovascular hypertension percentage of vascular reinterventions was also 18% (7/39).

Urological complications

There were no urological complications in the group of patients operated with modified method with kidney rotation. For comparison, patients operated classically had strictures in the ureteral junction in 3 cases (10%), bleeding from kidney’s pelvis (1 patient, 3%) and a concrement in pelvis (1 patient 3%), in a child with diagnosed fungal urinary tract infection. One patient due to the subpelvic narrowing of the ureter associated with ureter bending required nephrostomy and then stricture excision with ureteropelvic anastomosis.

Other post operative complications

One patient after surgery had extended lymphatic drainage from the abdominal cavity, which stopped spontaneously. The other, late complications in patients after kidney autotransplantation with its rotation, were 2 reoperations because of bowel obstruction (18%).

DISCUSSION

The primary surgical treatment of RVH, performed for the first time in 1938, was the removal of the kidney (10). From the early 70’s surgical treatment of children with RVH consisted mainly of nephrectomy. The search for other methods to preserve renal tissue, particularly in bilateral changes led to invention of different surgical techniques.

One method often used by general surgeons since 1952, but not applicable in pediatric patients, is endarterectomy of arteriosclerotic changes (11). The most commonly used procedure in adult surgery is a reconstruction of renal blood flow using autologus aortorenal bypass with saphenous vein. This method, however, is not recommended for pediatric patients because of the numerous complications associated with the development of aneurysm in the by-pass site (12). To avoid this complication authors recommend the use of Dacron mesh around the venal bypass to prevent its expanding (13). Frequently used in pediatric population are isolated arterial bypasses, most often with hypogastric artery (14, 15, 16), but this method is limited by the diameter of these small vessels in children which predispose to thrombosis of the anastomosis. Much more commonly in children, local excision of isolated stricture of renal artery with reimplantation to the aorta is performed (14).

It is possible however, only with correct structure of the aorta and short length of renal artery stenosis, not requiring a substantial shortening of the artery, re-enabling reanastomosis to the aorta.

Reconstructions of vascular tissue using synthetic materials (such as polytetrafluorethylene protheses) carry a higher risk of thrombosis in cases of a small diameter vessels, and are susceptible for neointimal overgrowth and infectious complications (14). One should also take into account children’s growth rate, leading to the so-called „growing out” of a prosthesis, that leads to the functional recurrence of vessel’s stenosis.

Non anatomical renal artery reconstructions: hepatorenal, splenorenal or iliorenal bypasses, were applied as a way to avoid direct clamping of the aorta, although due to the frequent thromboses in cases of small diameter of vessels, are not recommended for pediatric patients (14, 17).

In complex vascular pathologies renal autotransplantation is becoming increasingly popular. Center experience in organ transplantation, where ex-situ vascular repair techniques are often used, help in bringing on the procedure (14, 18, 19, 20). In our center, where since 1984 we have performed about 600 kidney transplants in children, we repeatedly met the need for reconstruction of damaged during the organ harvesting renal vessels. As well as difficulties with optimal fitting of renal and iliac vessels, so that to avoid folding of vessels or the urether (20) (fig. 2).

The solution to this problem would be to transplant kidneys into the opposite iliac fossa, which in the case of autotransplantation is
Modified renal autotransplantation in children with renovascular hypertension

associated with a significant enlargement of the operation site, or kidney transplantation on the same side but with uretral shortening and creating uretral anastomosis. The proposed method of kidney’s 180 degrees rotation allows for better arrangement of the vessels to anastomoses, and in cases which do not require ex situ reconstruction offers an opportunity to avoid the uretral anastomosis. This method allowed to reduce the number of urological complications after kidney autotransplantation. It is important to remember to position ureter of rotated kidney carefully so that it does not create sharp bends. Fixing the ureter in 2-3 points allows to avoid these complications (fig. 1 and 2).

In our study we compared group of children operated using classic and modified technique. We did not found any difference in the amount of vascular complications between the two groups during the post operative observation, while we observed significant difference in the occurrence of urological complications for the benefit of the group after the autotransplantation with kidney rotation. At the same time using this method of operation, we obtained the normalization of blood pressure and the possibility of performing a single arterial anastomosis for revascularization of the kidney. We have taken advantage from these experiences during subsequent operations.

CONCLUSIONS

Our good post operative results of modified operation technique are promising. We did not observe significantly higher rate of surgical complications. The effect of the treatment of hypertension and function of transplanted kidneys are good in the current, up to 7 years (on average 3.9 years), observation. Therefore, we decided to present our experience, but it still requires further, longer term observations, on a bigger group of patients.

REFERENCES

The first line of treatment of renovascular hypertension caused by renal ischemia induced by stenosis of renal arteries, includes surgical and endovascular therapy. So far more than 30 various methods of surgical treatment have been reported in the literature. Expansion of scientific boundaries and technological progress and clinical experience related to transplantation of allogenic kidneys led to the concept of kidney autotransplantation. This method has become the best treatment of renovascular hypertension not only in adults (described in 1994 by J. Szmidi in Polish Journal of Surgery), but also in children in cases requiring complex correction of stenoses of renal arteries, located distally to bifurcation of the renal artery or in the intrarenal segment. I do not have to emphasize that the surgical technique requires exceptional manual skills and delicate and precise operation. Only such management can ensure therapeutic success.

The progress and innovation in the commented study involves the authors’ modification of the method of kidney autotransplantation by its rotation by 180 degrees to ensure more beneficial position of anastomosed renal vessels without requirement of shortening and anastomosis of ureters. This allowed to avoid any urological complications that occurred in four patients who underwent kidney autotransplantation Proc without its rotation. The discussion reflects extensive knowledge and experience of experts in this area.

The results of kidney autotransplantation in children obtained by the authors are promising although this paper is just a preliminary report.

Submission of this report to “Polish Journal of Surgery” – a journal founded in 1893 by Association of Polish Surgeons – is a generous gesture for Polish surgeons by Professor Piotr Kaliciński – the most prominent specialist (not only in Poland) in the area of organ transplantation (especially kidneys and liver) in children. This emphasizes his greatness: he did not forget about his origin and wants to share his own, successful research ideas and his vast specialist experience with Polish colleagues – readers of “Polish Journal of Surgery”.

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