Arterial reconstructions of kidney allograft

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The adequacy of blood supply in the allograft is one of the main factors of kidney transplant vitality and function and the effectiveness of transplantation itself.

The aim of the study was to investigate the effectiveness and variants of arterial reconstructions of kidney allograft.

Material and Methods. The results of kidney transplantation were analyzed among 66 patients. During the period from 2012 to 2016, all of them were done kidney transplantation in the department of transplantology. There were 37 (56.1 %) men, 29 women (43.9 %), the average age at the time of surgery was 33.2±12.0 years. According to the aim of the study all the patients were divided into two groups: the first group included 12 (18.2 %) recipients, who received an arterial reconstruction. The age of the patients was 30.8±6.5 years, there were 6 (50 %) men, other – women. Another group involved 54 (81.8 %) patients without arterial reconstruction. The average age of recipients was 33.7±12.9 years, there were 31 (57.4 %) men, 23 women (42.6 %). We analyzed duplex examination of kidney allograft on the 7.6±1.9 day after kidney transplantation.

Results. According to the analysis of duplex examination the features of blood disorder in kidney allografts were not determined. The differences between groups were non-significant (p>0.05). There were not identified any stenosis, thrombosis or bleeding in any cases of arterial reconstructions of kidney allograft; function of kidney allograft has preserved for the period of 2.2±1.4 years.

Conclusions. Adequate arterial reconstruction of kidney allograft is effective and safe method of kidney preparation for transplantation.

Key words: kidney transplantation, allografts, renal artery.

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Arteriалні реконструкції ниркового аллотрансплантату

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Одним із принципових факторів життєздатності та функції пересадженої нирки, а отже й ефективності трансплантації, є адекватність кровотоку в аллотрансплантаті.

Мета роботи – вивчити ефективність і варіанти артеріальних реконструкцій ниркового аллотрансплантату.

Матеріали та методи. Проаналізовані результати трансплантації нирок 66 хворим. З 2012 по 2016 р. їм виконана пересадка нирок у відділенні трансплантації. Чоловіків було 37 (56,1 %), жінок – 29 (43,9 %), середній вік пацієнтів – 33,2±12,0 року. Згідно з метою роботи пацієнтів поділили на групи: першу становили 12 (18,2 %) реципієнтів, яким виконано артеріальне втручання на ниркові артерії трансплантату. Средній вік пацієнтів – 33,7±12,9 року, чоловіків було 6 (50 %), інші – жінки; друга група – 54 (81,8 %) пацієнтів без артеріальних реконструкцій. Средній вік реципієнтів – 31 (57,4 %), середній вік – 23 (42,6 %). Аналізували дуплексне сканування ниркового аллотрансплантату в середньому за період спостереження 2,2±1,4 року.

Результати. Під час дуплексного ультразвукового сканування ознак порушення кровотоку в ниркових аллотрансплантатах не виявлено. Відмінності між групами статистично невірогідні (p>0,05). У жодному випадку не зареєстровано стенозів, тромбозів або кровотеч; за період спостереження 2,2±1,4 року функція аллінірки збережена.

Висновки. Адекватна артеріальна реконструкція ниркового аллотрансплантату – ефективний і безпечний спосіб підготовки нирки до пересадки.

Артеріальна реконструкція почечного аллотрансплантату

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Одними з принципових факторів життєздатності та функції пересадженої почечкої, а отже й ефективності трансплантації, є адекватність кровотоку в аллотрансплантаті.

Цель работы – изучить эффективность и варианты артериальных реконструкций почечного аллотрансплантата.

Материалы и методы. Проанализированы результаты трансплантации почки 66 больным. За период с 2012 по 2016 г. им была выполнена пересадка почки в отделении трансплантации. Мужчин было 37 (56,1 %), женщин – 29 (43,9 %), средний возраст пациентов – 33,2±12,0 года. Согласно цели работы пациенты были разделены на группы: первую составили 12 (18,2 %) реципиентов, которым было выполнено хирургическое вмешательство на артериях трансплантата. Средний возраст пациентов – 30,8±6,5 года, мужчин было 6 (50 %), другие – женщины. Вторая группа – 54 (81,8 %) пациента, у которых не было необходимости в артериальных реконструкциях артерий. Средний возраст реципиентов – 33,7±12,9 года, мужчин – 31 (57,4 %), женщин – 23 (42,6 %). Мы анализировали дуплексное сканирование почечного аллотрансплантата в среднем на 7,6±1 суток после пересадки почки.
Results and Discussion

The structure of arterial reconstructions of kidney allograft was the following: in 8 cases (57%), general arterial ostium was formed, in 4 cases (29%) – additional upper pole renal artery was bound. In 1 case (7%) – previously formed common neo-ostium of renal artery was continued with the help of synthetic vascular prosthesis, in 1 case (7%) – the endarterectomy was done (with simultaneous formation of common ostium of renal artery).

Cold ischemia time in the first group was 2.25 (2.04–3.18), in another it was 2.0 (1.5–2.27) hours. According to the results of U-test as for Mann–Whitney’s method statistically significant differences between groups, prognostic value of criterion, correlational dependencies were established (p < 0.05).

As for sexual and age-old features, nosology of terminal state stage of chronic renal failure these groups are representative (p > 0.05).

For description of frequent data the percentages were used, the differences among groups were estimated with the help of χ2-test and Fisher’s exact test. Kolmogorov–Smirnov test was used to check up the form of data division. Continuousnormally divided data was denoted by the average value and standard deviation. Unmatched t-criterion was used for comparison of average data of independent samples. As for continuous data with division, distinctive from normal one, median, lower and upper quartiles were been in usage. In order to compare the groups in pairs U-test by Mann–Whitney was used (as for independent samples). The availability of connection between parametric data was evaluated with the help of correlation coefficient Pearson’s (r). Nonparametric data was estimated with the help of Spirman’s coefficient. The power of connection was interpreted following the notion of correlation’s coefficient in such way: from ±0.7 to ±1 – it is strong correlation, from ±0.3 to ±0.699 – it is middle correlation, from ±0.299 – it is weak correlation.

All types of analysis were performed with the usage of programmes of statistical analysis Microsoft Office Excel 2007 and “Statistica 6.0” for Windows (StatSoft Inc., США) v.6.1 license № AXXR712D833214FAN5. Differences between groups, prognostic value of criterion, correlational dependence were reliable at p<0.05. In all cases values p were bidirectional.

Material and Methods

The results of the kidney transplantation were analyzed among 66 patients. During the period from 2012 to 2016, all of them were done kidney transplantation in the department of transplantology of State establishment “Zaporizhzhia Medical Academy of Post-Graduate Education Ministry of Health of Ukraine” on the base of interregional centre of transplantology. There were 37 (56.1%) men, 29 women (43.9%), the average age of patients was 33.2 ± 12.0 years. All the patients in the early postoperative period were done the standard examinations for clinical records, ultrasonic examination with scanning of kidney allograft (the figures of ultrasonic examination are presented on average the 7.6 ± 1.9 day after kidney transplantation).

As for multiple renal arteries of donor kidney allograft from live related donor the ostium of the upper pole kidney allograft artery was dissected on the caudal surface. The ostium of the kidney allograft artery lower pole was dissected on the cranial surface for about 1.0 cm. Common neo-ostium was formed with two-lane uninterrupted suture (polypropylene suture 6-0) like “side-to-side”. As for multiple renal arteries, their length and distance between them were taken into account. As for hemodynamic little additional upper pole renal artery (diameter to 2 mm) the last one was bound.

Short renal artery was elongated by the way of anastomosis with synthetic vascular prosthesis GORE-TEX Ø 6 mm like “end-to-end” with the help of polytetrafluoroethylene suture 6-0. In case of revealing the atherosclerosis plaque of renal artery endarterectomy was done.

In all cases renal artery was anastomosed with external iliac artery like “end-to-side”.

According to the aim of the study all the patients were divided into two groups. The first group included 12 (18.2%) recipients, every one of them was done an arterial reconstruction of kidney allograft. The average age of patients was 30.8 ± 6.5 years, there were 6 (50%) men and 6 women (50%).

The second group involved 54 (81.8%) patients. They were not required for arterial reconstructions of the kidney allograft. The average age of recipients was 33.7 ± 12.9 years, there were 31 (57.4%) men, 23 women (42.6%).

As for sexual and age-old features, nosology of terminal stage of chronic renal failure these groups are representative (p > 0.05).

For description of frequent data the percentages were used, the differences among groups were estimated with the help of χ2-test and Fisher’s exact test. Kolmogorov–Smirnov test was used to check up the form of data division. Continuous

true differences (p = 0.020) are determined. Between surgery on the kidney allograft’s arteries and cold ischemia time the correlation is absent (R = 0.356, p = 0.018).

Secondary warm ischemia in the first group was 39.0 (20.25–44.0), in another one it was 26.5 (21.0–37.75) minutes. According to Mann–Whitney’s U-criterion the differences between groups are statistically unreliable (p = 0.174). Among arterial reconstructions of kidney allograft and secondary warm ischemia time correlation is not determined (R = 0.171, p = 0.176) (Table 1).

Artery stenosis of kidney allograft – is the most widespread vascular complication, which can be observed in the process of kidney transplantation [16]. Stenosis frequency varies within 5–23 % [1,3,12–14,17]. Probability of arterial stenosis increases in the process of transplantation of multiarterial kidney allograft. Poor surgical technique can also result in narrowing of the kidney artery: the damage of intima donor’s vessels or recipient by the vascular clamps, the damage of intima donor’s artery by the cannula during the process of perfusion; errors associated with the suture technique: purse-string effect of anastomosis narrowing, changing of blood flow by the stitch line, inappropriate stitching material, fiber-inflammatory reaction on the polypropylene; renal artery’s inflection as a result of its insufficient or excessive length; renal artery’s torsion; anastomosis “end-to-end” among the vessels, inappropriate diameter [1,3,12–14,17].

During ultrasonic examination of kidney allograft the following features of arterial stenosis are determined: pulse wave like “tardus-parvus”, peak systolic velocity (PSV) of blood flow in the renal artery >250 cm/s, formation between stenotic and prestenotic segments of velocity gradient >2:1, decreasing the index of resistance (IR) <0.56 [15,18]. Hemodynamic significant stenosis of kidney allograft artery (>70 %, pressure gradient >15 mm of mercury column) more likely leads to the kidney allograft’s function violation and has the tendency to the progress with the continuous risk of the transplant loss [1,12–17]. At the same time stenosis can lead to the kidney allograft artery thrombosis [19].

PSV of blood flow in the first group was 89.1±24.6, in average in another group was – (96.9±33.6) cm/s. Following the results of t-criterion for independent samples the differences among the groups are statistically unreliable (p = 0.450). Between the surgery on the transplant’s arteries and PSV, there is no correlation (r = −0.096, p = 0.457).

The average index of resistance in renal artery of the transplant in the first group was 0.7±0.2, in another group was – 0.6±0.1. Following the criterion for independent samples the significant differences were not noticed (p = 0.448). Between the arterial reconstructions of kidney allograft and value IP correlation is not determined (r = 0.095, p = 0.448) (Table 2).

The frequency of artery thrombosis of allograft varies within 0.2–7.5 %. Thrombosis develops during the first week (the most frequently during the first two-three days) after kidney transplantation [1,3,12–16]. The risk factor of arterial thrombosis is the use of multiarterial kidney allograft. Some errors of surgical technique can lead to the thrombosis: unidentified intimal tear, technique defects of vascular stitch, artery’s inflection (if the artery is longer than vein or if there is wrong localization of anastomosis formation) [1,3,12–16,20]. The lack of arterial and vein blood flow in kidney allograft is determined in the process of Doppler study [15,18]. Taking into account the lack of collateral vessels and low tolerance for warm ischemia such grafts are necessary to remove in the most cases [1,3,12–16,20].

In the process of Doppler study, the features of critical violation of blood flow in kidney allograft were not identified (Table 3). The differences among the groups are statistically unreliable (p > 0.05).

In accordance with the literature data different variants of vascular anastomosis in the process of multiarterial kidney allograft transplantation are proposed. In the process of transplantation of dead donor kidney multiple renal arteries on the common aortic Carrel’s area anastomose like “toward the end” with external iliac artery of recipient. If the length of Carrel’s aortic area is more than 2–2.5 cm, it is possible to divide the vessels and anastomose the renal artery with external iliac artery separately. It is also possible to form the common arterial ostium after dissection of the excessive part of aorta between renal arteries [2,3,12,13,15].

The majority of authors insist on the preservation of polar renal arteries, especially as for lower pole one because it blood supplies to the ureter [2,3,12,13,15]. Ligature of upper pole artery can be safe [21], especially when it has small hemodynamic value (diameter to 2mm) [2,3,13,15].

In the process of transplantation of poliarterial kidney from a live donor some authors recommend to form the common Carrel’s area with the help of donor gonadal vein [22]. Other authors report about good results of additional pole renal artery anastomosis with lower epigastric recipient’s artery like “end-to-end” [2,3,12,13,15]. There is a point of view, according to which it is better to anastomose upper pole renal artery with upper epigastric artery, lower pole artery of graft with upper epigastric recipient’s artery [23]. It is possible to perform the anastomosis of additional artery

### Table 1. Ischemia time

| Ischemia time                | First group (n=12) | Second group (n=54) |
|-----------------------------|--------------------|---------------------|
| Cold ischemia (hours)        | 2.25 (2.04–3.18)   | 2.0 (1.5–2.27)*     |
| Secondary warm ischemia (minutes) | 39.0 (20.25–44.0) | 26.5 (21.0–37.75)   |
*: p < 0.05 with the usage of Mann–Whitney’s U-criterion.

### Table 2. Average indexes of ultrasonic examination of kidney allograft arterial blood flow

| Features of ultrasonic examination | The first group (n=12) | The second group (n=54) |
|------------------------------------|------------------------|-------------------------|
| PSV (cm/s)                         | 89.1±24.6              | 96.9±33.6*              |
| IR                                 | 0.7±0.2                | 0.6±0.1*                |
*: the p-value was non-significant (p > 0.05).

### Table 3. Duplex examination with scanning of kidney allograft

| Features of ultrasonic examination | The first group (n=12) | The second group (n=54) |
|------------------------------------|------------------------|-------------------------|
| The lack of blood flow in kidney allograft, n/% | 0/0.0 %                | 0/0.0 %*                |
| Pulse wave like “tardus-parvus”, n/%     | 0/0.0 %                | 0/0.0 %*                |
| IR <0.56, n/%                       | 2/16.7 %               | 14/25.9%*               |
| PSV in renal artery >250 cm/s, n/%     | 0/0.0 %                | 0/0.0 %*                |
| Velocity gradient (between stenotic and prestenotic segments) >2:1, n/% | 0/0.0 %                | 1/1.9%*                 |
*: the p-value was non-significant (p > 0.05).
Conclusions

1. In the kidney transplantation with the peculiarities of vascular architectonics, elongation of ischemic time takes place, taking into account the performance of vascular reconstructions on the stage of «back table» and complexity of vascular anastomosis formation in the process of transplantation.

2. Adequate arterial reconstruction of kidney allograft are effective and safe method of kidney preparation for transplantation [1, 3, 12, 13, 15]. It permits to increase the donors' potential. It is important in the view of donor organs shortage nowadays [1].

3. In any case of kidney allograft arterial reconstruction there were not registered any stenosis, thrombosis or bleeding; the function of kidney allograft is preserved (on the 2.2±1.4 years).

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