

Current practice with grafts with multiple renal arteries in kidney transplantation: role of the methylene blue in the lower pole

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Abstract. Kidneys with multiple renal arteries (MRAs) from different patches, may provide to the surgeon additional technical difficulties that make kidney transplants very challenging. MRAs have been largely debated over the years whether to be anastomosed or not due to the disappointing outcomes when it comes to inappropriate ligation or anastomosis. Some authors empirically reassure that smaller branches can be safely ligated and dissected without intraoperative and postoperative complications or compromising the functional recovery of the graft. Literature is poor about the possible differences in the management of superior and inferior polar arteries. Inferior polar arteries represent a topic of great interest as they may also supply the proximal ureter. The aim of this article is to merge the current knowledge about the management of inferior polar arteries and to highlight if there is any role of the methylene blue dye (MB) in the study of the ureteral vascularization in kidney transplantation. MB can be considered a safe and simple tool of vascular perfusion assessment in kidney transplantation. By injecting the dye-solution into the inferior MRA hidden ureteral branches can be unmasked and guide the surgeon to preserve important vessels. In view of their fundamental role in the vascularization of the ureter, the lower polar arteries of the graft, should be invariably studied by MB. It provides an objective, simple and fast tool for the evaluation of the ureteral vascularization when injected through the inferior MRA of the graft. (www.actabiomedica.it)

Key words: multiple renal arteries, kidney polar arteries, methylene blue, kidney transplantation.

Introduction

Kidney transplantation is a routine, but nevertheless complex procedure frequently performed in transplant centres. Graft or recipient anatomical variations may provide to the surgeon additional technical difficulties that make kidney transplants very challenging in terms of successful postoperative outcomes. (1) Grafts were originally considered optimal for transplantation when presenting with a single renal artery (SRA), until organ shortage forced the surgeons to reconsider grafts

with multiple renal arteries (MRAs) for transplantation. (2) Accessory branches have largely been debated over the years whether to be anastomosed or not due to the disappointing outcomes when it comes to inappropriate ligation. (3)

In the past, kidneys with accessory arterial branches have triggered major concerns for transplantation due to the higher risk of postoperative vascular and urological complications.³ Some evidence highlights the increased risks for vascular thrombosis, acute tubular and ureteral necrosis, poor graft function and

prolonged cold ischemia time due to the technical times at the back table. Furthermore, the extended intraoperative warm ischemia time because of technical times and complexity of anastomosing also held back the surgeons from selecting this organ class for transplant. (4,5)

Although being object of surgical concern, MRAs gained interest and several solutions have been proposed over the years to optimize the positive organ selection for transplant. Large consensus endorses the transplantation of grafts presenting MRAs which has yet demonstrated to be safe, however certain aspects should be carefully scrutinized. (6,7) Some authors empirically reassure that branches smaller than 2 mm in diameter can be safely ligated and dissected without intraoperative and postoperative complications or compromising the functional recovery of the graft. (8)

Moreover, studies support the hypothesis that MRAs supplying less than 10% of the total parenchymal blood supply can be also safely ligated. (9) Literature is poor about the possible differences in the management of superior and inferior polar arteries. Inferior polar arteries represent a topic of great interest as they may also supply the proximal ureter.

Methylene blue (MB) is a safe and low-toxic dye already largely adopted to assess anastomotic leaks or surgical outcomes in various disciplines such as urology or upper GI tract surgery. (10-14) The aim of this article is to discuss the current knowledge about the management of MRAs and to highlight the role of the MB dye as tool of inferior MRAs assessment in kidney transplantation.

Methods of procedure

While preparing the donor's kidney for transplantation in a sterile ice bath at the back-table, Methylene Blue (Byam, Paris, France), diluted 1/50 in Celsior Solution (approximately 40 cc) is injected through the aortic patch to visualize the area of vascular supply from the accessory renal artery of interest over the kidney surface. Few seconds after injection, are sufficient to evidence the extension of the polar renal artery territory. Figure 1. While the parenchyma appears the first to be colored, the vascularization of



Figure 1. Methylene blue dye injection in the inferior accessory renal artery evidences the area of perfusion.

the contiguous structures (e.g. ureter) requires the injection of a greater amount of MB dye solution to be detected. Figure 2.

Highlights

Questions: Can a multiple renal artery be safely ligated?

Findings: The clinical and surgical evaluation require different considerations when approaching an inferior or superior polar artery. Indeed, the



Figure 2. Small arterial branches on the upper ureter are recognizable after the injection of the solution in the inferior polar artery.

importance of superior polar arteries can be related to the effective diameter of the vessel, to the total mass and weight of the kidney, in relation to the mass of the recipient. In general, they may not represent a problem except in terms of rare cases of delayed graft function. (15) Therefore, the 2 mm cut-off or the 10% of the vascular supply definitions may be safely applied to this context. While approaching the inferior polar arteries some thoughts are worth of consideration: besides the parenchymal supply, MRAs to the inferior pole are also frequently involved in the vascularization of the ureter. Consequently, it is questionable to safely rely on the above-mentioned definitions and the perfusion area should be carefully evaluated to avoid postoperative complications involving the ureter.

Meaning: Methylene blue dye can be considered a safe, simple, and fast tool of vascular perfusion assessment in kidney transplantation. Vascular dye-perfusion may unmask hidden ureteral branches and objectively guide the surgeon to preserve vessels of paramount importance. When there is sign of ureteral perfusion from the inferior MRA, the vessel should always ought to be preserved due to the high risk of ureteral ischemia and leaks.

Discussion

The management of multiple renal arteries in kidney transplantation has historically been controversial until recent evidence in support of their safe management. (5) However, some questions in the field are still pending. The debate about which MRAs can be safely ligated or not is actual and a simple, practical, and objective guide is lacking.

Several tools and parameters of self-assessment for the MRA ligation have been proposed over the years. Some authors reassure that branches smaller than 2 mm in diameter can be safely ligated and dissected without intraoperative and postoperative complications or compromising the functional recovery of the graft. (8) Other authors safely rely on the fact that the percentage of surface perfusion can provide the estimate to a safe decision to ligate a MRA with an empirical 10% cut-off. (9) In these cases, the explanation is presented by means of subjective meters of evaluation that may not fully adhere to every circumstance.

From a recent meta-analysis, kidneys with accessory renal arteries resulted to be characterized by higher renal and ureteral complication rates, delayed graft function, longer warm ischemia time and higher ureteral complications; the 5-year graft survival and long-term outcomes were however similar to single renal artery (SRA) grafts, therefore supporting the overall safety of the procedure. (15-17) In 2007, Gawish et al. shared their experience with MRA-allografts concluding that despite the complex technical effort, these grafts had acceptable outcomes comparable to single-artery renal grafts. (4)

Multiple renal arteries may enter the kidneys directly, usually into the superior or inferior poles. It is

important to be aware that such vessels are terminal - end arteries; such aspect should be particularly taken into consideration when part of the vascular supply of the renal pelvis or when part of the upper ureter hangs also on the MRA. (18)

Loss or ligation of arterial branches other than the main renal artery, like superior, inferior polar arteries or MRAs in general, represent a topic of great interest as is occasionally responsible for delayed graft function, segmental ischemia of the graft, or ureteral necrosis after renal transplantation. (3,15,17) To minimize the risk of post-operative complications, grafts MRAs should be carefully studied at the back table to avoid surgical mistakes which could complicate the post-operative course of the transplant patient. (3)

In our opinion, the above-mentioned empirical parameters, cannot entirely support the surgeon's choice but should be contextualized to the specific case. The 2 mm cut-off, or the 10% supply rules can surely be a useful indication but in fact direct correspondence between the diameter of the artery and the supplied area over the kidney may lack or mislead the surgeon. Furthermore, indeed, such approach could find its best solution when applied to the superior polar arteries: in general, their ligation following these criteria may not represent a problem except in terms of rare cases of delayed graft function. (15) As the improper ligation of a inferior MRA, besides the delayed graft function, may also display into ureteral injuries, we believe that the management of inferior polar arteries may currently not find its best support within these criteria and should always ought to be preserved, if not accurately studied. (3)

Methylene blue (MB) is a low-toxic dye already largely adopted to assess the vascular perfusion, anastomotic leaks or surgery outcomes in various surgical disciplines, such as urology or upper GI tract surgery. (10-14) Li et al. recently reported their positive experience with MB dye in kidney transplantation. We also use MB to determine whether to ligate or preserve accessory arteries from deceased kidneys before implantation. Unlike Li, we have no experience about the real matching between the extension of the colored regions with MB and renal function. The authors suggest that MB perfusion provides an easy and effective method of making decisions about arterial ligation and helps to

preserve kidney function without increasing the number of complications after transplantation. (12) With more than 20 cases of grafts presenting MRAs and studied with this technique we neither detected any early or late vascular or ureteral complications.

Beforehand, in our opinion, all MRAs should be studied and always ought to be preserved. Particular attention should be paid to the arteries whose perfusion concerns the lower pole. The arterial blood supply of the proximal ureter can occasionally rely also on MRAs. Figure 2 and Figure 3 are showing a case of our series where the upper ureteral trunk appears to be colored after injection of the methylene blue dye into the inferior MRA from the aortic patch. The ligation of an accessory branch supplying the ureter, as presented, could lead to a high risk of ureteral ischemia or necrosis. For instance, we report a case where the inferior MRA preservation was not possible to be achieved due to technical difficulties. After the successful completion of the procedure, the patient developed a severe ischemia and necrosis of the upper ureter requiring ureterostomy and lately re-transplantation.

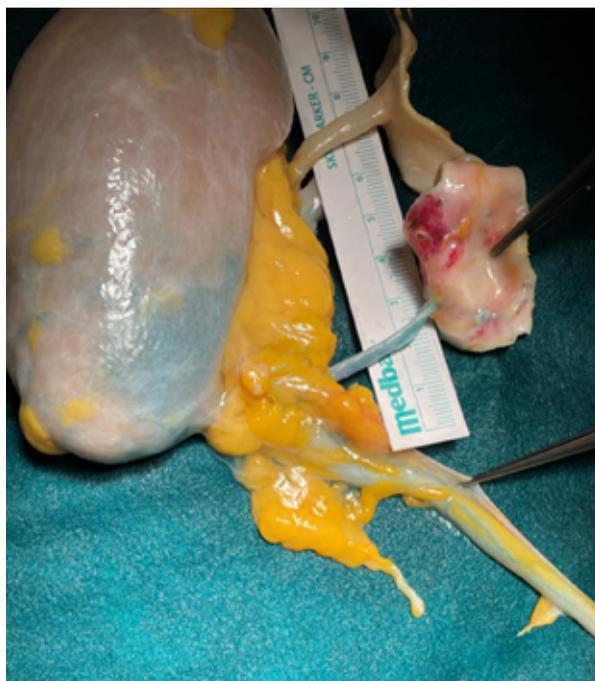


Figure 3. Small arterial branches on the upper ureter are recognizable after the injection of the solution in the inferior polar artery.

By our experience, we use to decide whether to ligate only intraoperatively by evaluating firstly the recipient's conditions at the time of implantation. The presence of atheromatous plaques on the accessory branch patch from the graft is a fact that we take into consideration before deciding whether to anastomose a polar artery. Due to the higher risk of anastomotic failure, we prefer not to anastomose when the graft patch presents with macroscopic evidence of atheromas. However, when there is sign of ureteral perfusion from MRA we always strive to preserve the vessel. Regarding, several authors identified safe alternative strategies of MRA anastomosis with the inferior epigastric artery. Similarly, we tend not to anastomose MRAs with small territory of distribution if the surgical field is difficult as in obese patients or retransplants. (3,19)

It is always difficult to judge whether to keep the MRAs and polar arteries or not, however the MB seems a useful tool to weigh these decisions up. The advantages of this procedure are multiple: in fact, MB usage is a simple, fast and safe technique, which provides an objective assessment of the perfused area not only over the kidney surface but also on the ureter. Routine screening with MB-dye at the back table could significantly reduce the rates of post-operative ischemic injuries of the graft and urological complications as consequence of improper MRA ligations.

Limitations

After injecting the MB dye in the inferior polar artery – MRA we could not establish the presence and comparative grade of urethral perfusion from the main renal artery. Therefore, further prospective studies with a greater plethora of cases could help in the final decision about the management of this controversial surgical aspect in kidney transplants.

Conclusions

Multiple renal arteries often require extra technical effort for a successful completion of the surgical procedure in kidney transplant. Subjective parameters of MRA ligation assessment can be risky and

not always sufficient to guarantee a successful surgical choice. Methylene blue dye provides an objective tool for the evaluation of the arterial perfusion when injected in the MRA. Routinary use of MB in the self - assessment of grafts presenting MRAs should be encouraged in difficult cases as it represents a safe approach to reduce the rate of ischemic injuries to the ureter deriving from improper ligations without a scrupulous study of the vasculature.

Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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