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# Indocyanine green utility in uterine transplantation

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## ABSTRACT

The role of indocyanine green has been widely studied so far and numerous applications and benefits have been demonstrated. Therefore, the wide implementation of the method allowed a real time visualization of the vascular and lymphatic branches which should be preserved during different procedures in order to minimise the risk of postoperative complications. In the last years the method has been also proposed in order to achieve a real time visualization of uterine arteries during uterine transplantation, and therefore to maximize the chances of success of this demanding procedure. The aim of the current paper is to discuss about the utility of indocyanine green injection during uterine transplantation.

**Keywords:** indocyanine green, vascular anastomoses, uterine transplantation

## INTRODUCTION

Indocyanine green has been widely proposed in the last decade with multiple purposes: to detect sentinel lymph node, to provide a better preservation of the greater lymphatic vessels and to avoid secondary limb lymphedema after axillar or inguinal lymph node dissection or to preserve vascularization of different flaps during reconstructive procedures [1-4]. Once the benefits of the method have been clearly demonstrated, indocyanine green has been also proposed in order to assess the functionality of vascular anastomoses [5,6].

## THE ROLE OF UTERINE TRANSPLANTATION

As for the surgical procedure of uterine transplantation, it has been proposed in the last decade in order to treat infertility, the first born after this procedure being reported by professor Brannstrom in 2015 [7]. At that moment, a 35 year old with Rokitansky syndrome (congenital absence of the uterus) was submitted to an uterine transplantation, the donor being a 61 year old two parous woman. One year after uterine transplantation she was submitted to her first embryo transfer and she gave birth to a male baby of normal weight 31 weeks later [7]. Once this great success was reported, attention was focused on wider implementation of uterine transplantation and on improving the surgical techniques in order to maximize the fertility results.

## THE UTILITY OF INDOCYANINE GREEN ADMINISTRATION IN UTERINE TRANSPLANTATION IN ANIMAL MODELS

The utility of indocyanine green injection in uterine transplantation has been recently studied especially in animal models (Figure 1); therefore, in the study conducted by Dion et al. and published in 2019 the authors published their experience obtained after uterine auto-transplantation in six multiparous Yucatan female pigs. After performing the hysterectomy the specimen was maintained at a temperature of 4°C for 60 minutes afterwards it was transplanted

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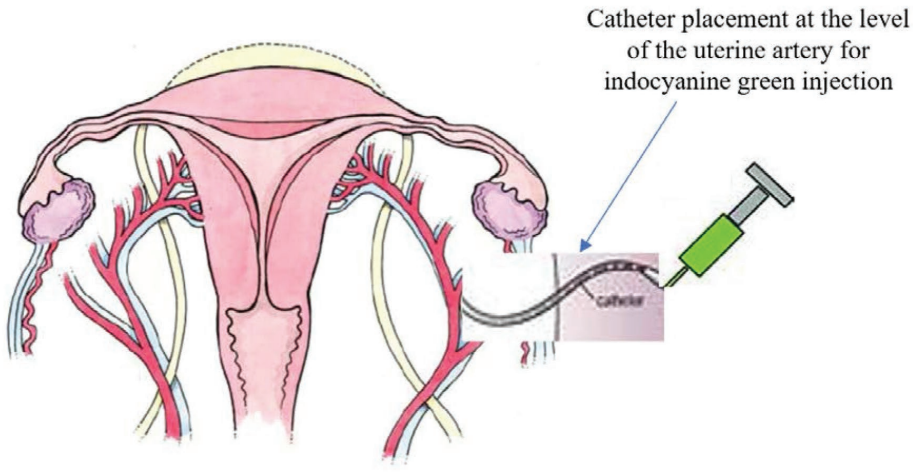


**FIGURE 1.** Experimental model using a harvested macaque uterus. The picture shows the placement of a catheter inside the uterine artery for indocyanine green perfusion

in an orthotopic manner. The following termino-lateral vascular anastomoses were performed: between the utero-ovarian veins and the external iliac veins and between the uterine arteries and external iliac arteries. The patency of the vascular anastomoses was studied through a Doppler ultrasound of the uterine arteries followed by indocyanine green administration. Therefore, infrared light and administration of indocyanine green provided a real time observation of the uterine vascularization and, in the meantime the recognition of anastomotic leaks. In the following days, one animal model died due to fulminant bleeding at the level of the anastomosis, another one died due to respiratory insufficiency, two other cases presented a necrosed uterus at the 10 day follow up and the remaining two cases were alive and presented a viable uterus (when explored by a pelvic magnetic resonance imaging). This study came to demonstrate the necessity of having an objective, powerful tool in order to analyse the functionality of vascular anastomoses [8].

Another study conducted on animal models which aimed to assess the effectiveness of indocyanine green in uterine transplantation was conducted by Shockley et al. and included six females baboons. In three cases the venous uterine vascularization was interrupted while in the other three cases the arterial vascularization was interrupted. In all cases reanastomoses were performed in the infrared light, after indocyanine green administration; postoperatively no case of uterine necrosis was observed while menstruation was preserved demonstrating therefore the efficacy of the method [9].

The method has been also proved to be efficient in a sheep model submitted to uterine transplantation, indocyanine green administration being successfully performed in order to provide an effective intraoperative and postoperative blood flow monitoring in the transplanted specimens [10].

## THE UTILITY OF INDOCYANINE GREEN ADMINISTRATION IN UTERINE TRANSPLANTATION IN HUMAN

After demonstrating the efficacy of the method in animal models, indocyanine green injection has been recently added as part of the surgical procedure in human. One of the first papers in which indocyanine green administration was postulated has been recently published by Mats Brannstrom, the first gynecologist who had reported a successful pregnancy after uterine transplantation in 2015. This time the Swedish study group conducted by professor Brannstrom reported eight cases of women submitted to uterine harvesting by the use of DaVinci robot, in all of them indocyanine green injection being administrated in order to provide an efficient identification of all blood vessels. This identification was possible after injection of 0,25mg /kg of indocyanine green and Firefly imaging of the operative field by the use of DaVinci Xi system [11].

## CONCLUSIONS

Indocyanine green injection and near infrared imaging seem to be a useful and effective tool in order to assess the vascularization of the uterus during transplantation. The method seems to be efficient both during harvesting and for creating the anastomoses and for providing a real time visualization of the blood supply. However, the method is still in an experimental phase, most reports originating from animal models.

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