The Strategy of Vascularised Transplantation of the Fallopian Tube

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SUMMARY

Severely damaged Fallopian tubes constitute a significant cause of human infertility, with a virtually hopeless prognosis. Advances in surgical techniques have made vascularised transplantation of the oviduct technically feasible, and this communication describes an original technique currently applicable in the experimental animal.

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Infertility caused by severe damage or previous excision of the Fallopian tubes remains a significant problem in modern gynaecological practice. While other solutions have been attempted, vascularised homograft transplantation of the oviduct has not received much attention. Preliminary success, in the form of a viable, non-rejected Fallopian tube removed from an unimmunosuppressed pig 134 days after transplantation, was recently reported.[1]

This communication describes the technique used for vascularised transplantation of the Fallopian tube in the experimental animal.

MATERIAL AND METHODS

Pigs of the Large White X Landrace variety, aged from 6 to 9 months, were considered suitable for this study.

Anaesthesia was induced with thiopentone sodium, administered via a fine needle into an ear vein. The anaesthetic was maintained with a mixture of nitrous oxide and oxygen, introduced by means of a positive pressure respirator. Muscular relaxation was achieved with diallylnortoxiferine and was reversed with suitable doses of atropine and neostigmine when the procedure was completed.

Operative Technique

The donor: The abdomen was opened with a subumbilical midline incision, by using a cutting diathermy knife. The bicornuate uterus was elevated, while the bowel was displaced with two large swabs which had been moistened with a solution of 5 000 units heparin in 1 litre normal saline.

The right cornu was elevated (Fig. 1) and an incision in the posterior abdominal peritoneum was made to expose the lower part of the inferior vena cava and the commencement of the right common iliac artery at the bifurcation of the aorta.

Once the right hypogastric artery had been defined, this vessel, together with the proximal portions of the internal pudendal, uterine and superior vesical arteries. were mobilised by dissecting them free of their accompanying veins and surrounding fascia (Fig. 2).

At this stage the animal was heparinised by intravenous administration of 20 000 units heparin.

The vascular arcades were then carefully inspected to ensure that the blood supply to the distal uterine cornu and Fallopian tube (oviduct) would not be interrupted.

The intervascular segments of the broad ligament were cauterised with the diathermy knife (Fig. 3). At this stage all branches other than those communicating with the intended transplant specimen were doubly ligated and transected. Particular care was taken to ensure that major veins communicating with the ovarian vein were not interrupted by this process.

Then the vascular arcades were re-checked from both the medial and lateral aspects of the broad ligament. When all other branches had been carefully ligated and divided, the remaining portions of the broad ligament were divided with the diathermy knife.

The operative procedure was now focused on the dissection of the right ovarian vein. All vascular branches other than those arising from the distal uterine cornu and the oviduct were defined, ligated and transected. These included the right ovarian artery, and major venous branches from the right ureter. The ovarian vein was defined right to its termination into the vena cava. Major para-aortic lymph glands in the operative field required careful excision to facilitate clear exposure of the vena cava at this site. This major vessel was then cleared of any fascia, together with the outer adventitia, in the vicinity of the termination of the ovarian vein.

At this stage the transplant specimen was in continuity with the donor at only three points, viz. the uterine cornu, the uterine artery and the ovarian vein.

The superior vesical artery was then ligated and transected, as was the uterine artery. A vena-caval clamp was applied (Fig. 4) and a suitable patch of vena cava was excised around the ovarian vein by means of scissors specifically designed to facilitate this aspect of the procedure (Fig. 5).

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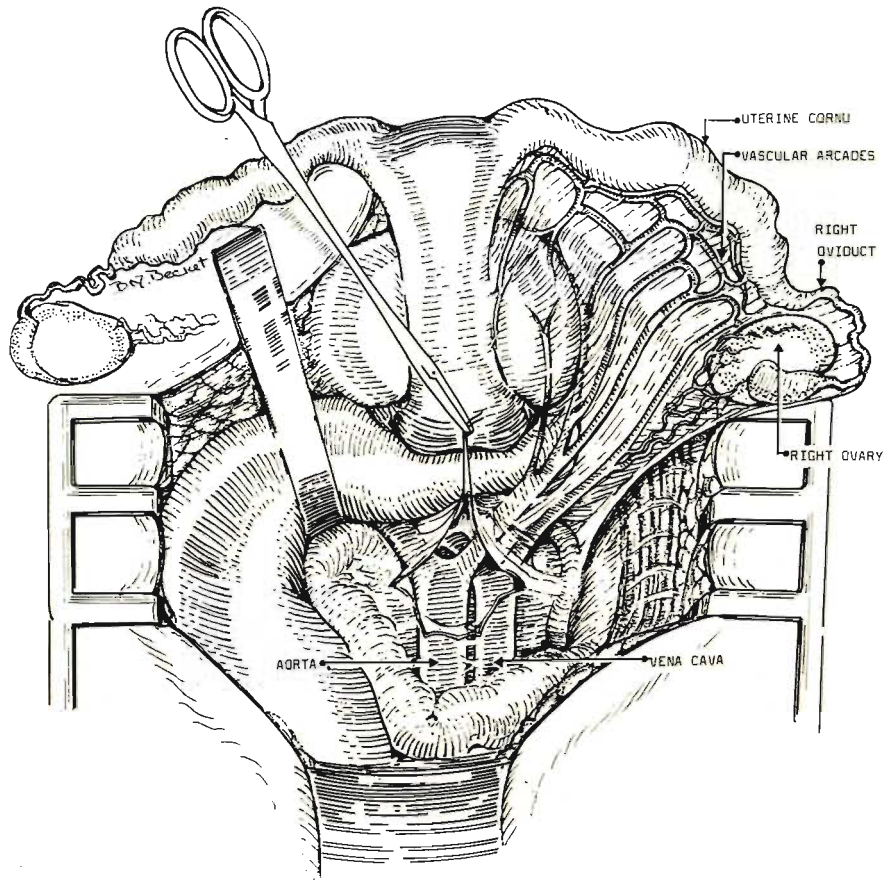

Fig. 1. Appearance of pig genitalia showing initial peritoneal incision to expose commencement of pelvic vessels.

A fine arterial catheter was then inserted into the uterine artery and the intact donor specimen (Fig. 6) was gently perfused with a solution of plasmalyte B combined with 10 000 units of heparin and glucose 50 g/litre, cooled to 10°C. The oviduct was kept in a cooled dish containing triamcinolone acetate (Ledercort) and gentle perfusion was maintained while the operation continued.

The donor vena cava was repaired with a continuous 6 - 0 silk suture. The uterine artery and cornual pedicles were ligated, abdominal packs were removed and the abdomen was closed.

The recipient: The abdomen was opened with a right paramedian incision approximately 5 cm above the umbilicus and continued subumbilically as a midline incision. Bowel packs were inserted as described previously, but these were placed higher up in the abdomen to facilitate exposure of the lower third of the inferior vena cava.

The internal pudendal artery was exposed as described previously, and freely mobilised for its proximal 4 - 5 cm. It was cleared of surrounding fascia.

The inferior vena cava was exposed by division of the posterior peritoneum at a point approximately 4 cm above the site of entry of the ovarian vein. This vessel was dissected free of the aorta and its anterior surface was cleared of any surrounding fascia. The right distal cornu and oviduct were then excised.

The recipient sites of cornu, internal pudendal artery and vena cava were now ready to receive the donor specimen (Fig. 7).

Venous Technique

Using 6 - 0 silk sutures lubricated with sterile liquid paraffin, the ovarian venous patch was anastomosed in the following manner: after the application of a large vena-caval clamp to the recipient vena cava, a longitudinal incision was made on the anterior aspect of this vessel with a fine scalpel (Fig. 8a). This incision was transformed into a diamond-shaped opening by the insertion of two lateral stay sutures, which were held in small rubber-covered artery forceps (Fig. 8b). These lateral stay sutures, along with two others placed at the upper and lower ends of the vena-caval incision, were then placed through the donor venous patch. This was held in position by ligation of the stay sutures (Fig. 8c). The edges of the anastomosis were approximated by the insertion of a continuous suture line between the stay sutures

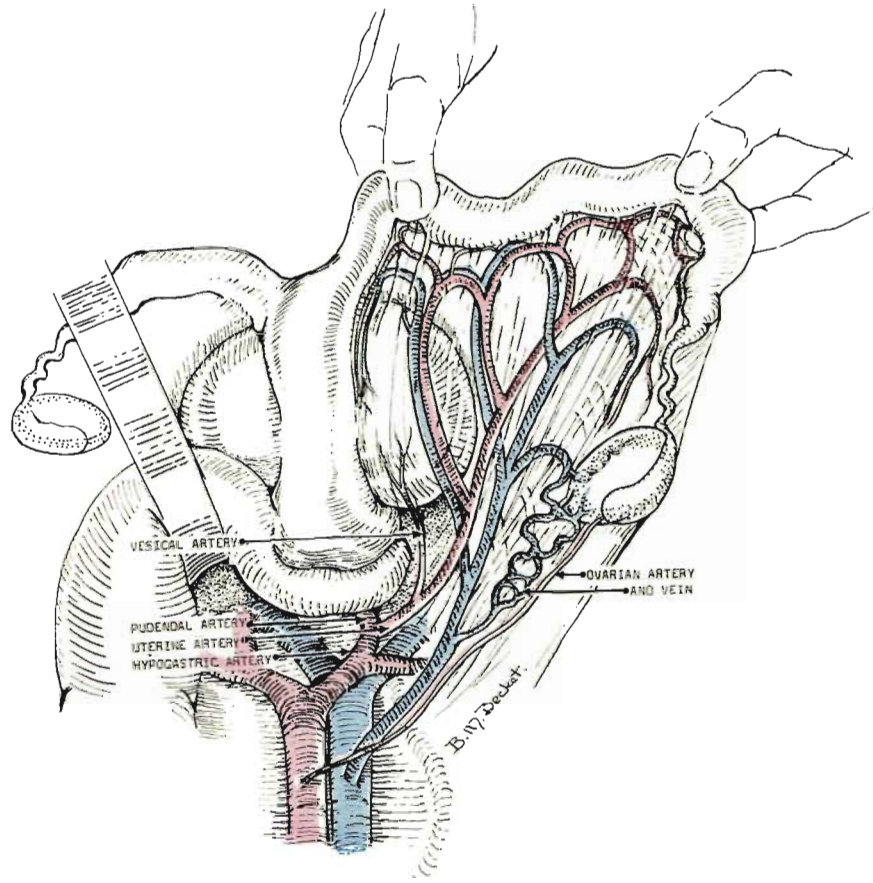

Fig. 2. Blood supply of the proposed site of dissection.

(Fig. 8d). This suture line was secured at the four suture points by tying it off with one of the ends of the stay sutures. The edges of the anastomosis were repeatedly irrigated with a solution of 10 000 units heparin/litre saline during the insertion of the suture line.

The vena-caval clamp was removed after completion of the anastomosis, which was gently compressed with small, dry, gauze dressings for approximately one minute before checking the haemostasis of the suture line. Any bleeding points were closed by the insertion of interrupted 7-0 silk sutures.

Arterial Anastomosis

Irrigation of the vessel ends with heparinised saline was performed as described above. In addition, the site of the anastomosis of the opposing arteries was repeatedly sprayed with a 2% solution of procaine hydrochloride. Silk sutures (7-0) lubricated with sterile liquid paraffin were used to complete the arterial anastomosis in the following manner: two stay sutures were inserted through the vessel ends at an angle of approximately 120° and ligated (Fig. 9a). Their short ends were held in the rubber-covered ends of small artery forceps.

The anterior wall of the vessel was then reconstituted by the insertion of a continuous suture line (Fig. 9b). After ligation of this suture line at the distal stay suture. the vascular clamps were released temporarily to expel any clots present in the ends of the vessels. The vessel was now rotated, to make the posterior wall of the vessel anterior (Fig. 9c). This wall of the vessel was closed by the insertion of a continuous suture line through all its layers, as had been performed on its anterior aspect. The vascular clamps were then removed.

Cornual Anastomosis

The opposing ends of the cornua were approximated in two layers. A continuous suture of 6-0 polypropylene was inserted through the muscular coat, and the endometrial layer was excluded from this suture line. The outer suture line was constituted by interrupted 3-0 polypropylene sutures, which were inserted through the serosa and outer muscular layer in such a manner as to cause slight inversion of the cornual anastomosis.

Completion of Operation

The opposing edges of the donor and recipient broad ligament were approximated with interrupted 4-0 poly-

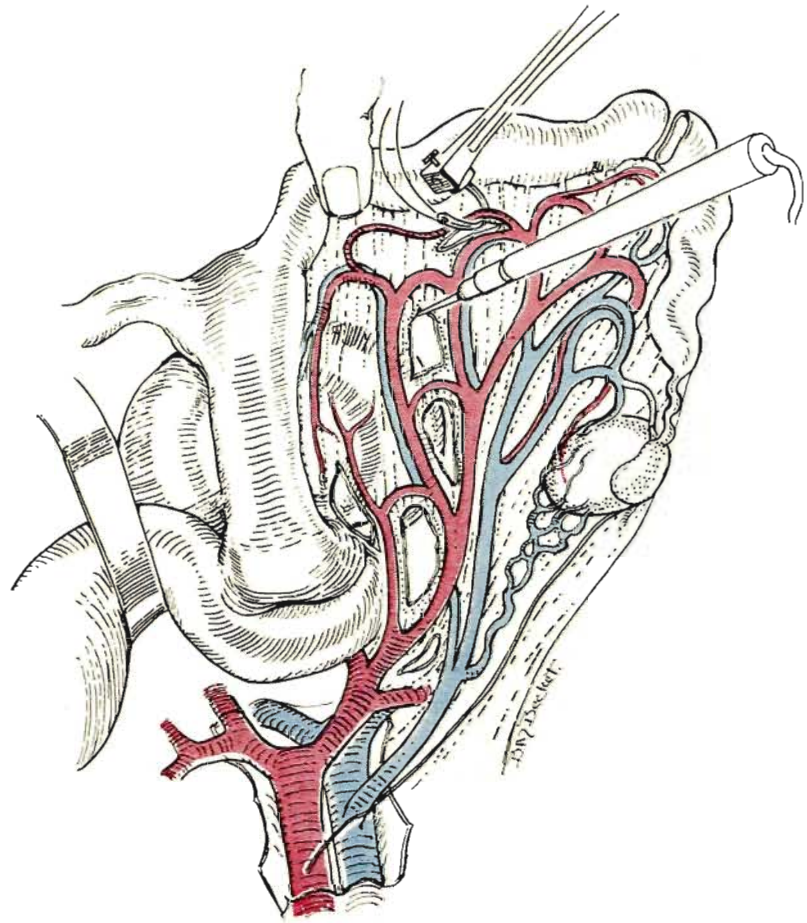

Fig. 3. Assessment and diathermy of vascular arcades. Note the continuous blood supply to oviduct and proposed site of incision.

propylene sutures.

The donor ovary was excised after ligation of its vessels close to the hilum of the structure, which was then sutured to the ovarian ligament of the recipient. The fimbrial end of the transplant specimen was now situated close to the recipient ovary. The appearance of the completed anastomoses of the ovarian venous patch. the uterine artery and the two ends of the cornu is shown in Fig. 10.

The bowel packs were removed. the abdomen was irrigated with a solution containing 5 000 units heparin and 2 g chloramphenicol/litre normal saline. Five hundred millitres of this fluid were left in the abdomen, which was then closed in layers. A subcuticular nylon skin suture completed the operation.

MODIFICATIONS IN OTHER ANIMALS

Canines

The above technique was equally applicable in dogs. with the following modifications.

The abdominal incision was made from just below the xiphisternum to the symphysis pubis to facilitate exposure of the site of entry of the ovarian vein into the vena cava. To avoid damage to the right ureter, which was situated very close to the right ovarian vein near its site of entry into the vena cava, it was found expedient to place a linen tape around this structure, so that it could be readily defined at all stages of the dissection procedure. The venous anastomosis was completed with 6 - 0 silk sutures. The arterial anastomosis required 9 - 0 nylon sutures and was performed with the use of an ocular loupe with a threefold magnification. It was necessary to incise the ovarian capsule to remove the ovary. Reinsertion of the transplanted Fallopian tube into this structure was a difficult and intricate procedure.

Sheep

The operation of vascularised transplantation of the oviduct in this animal was very similar to that described in the pig, although the following modifications in technique were applied.

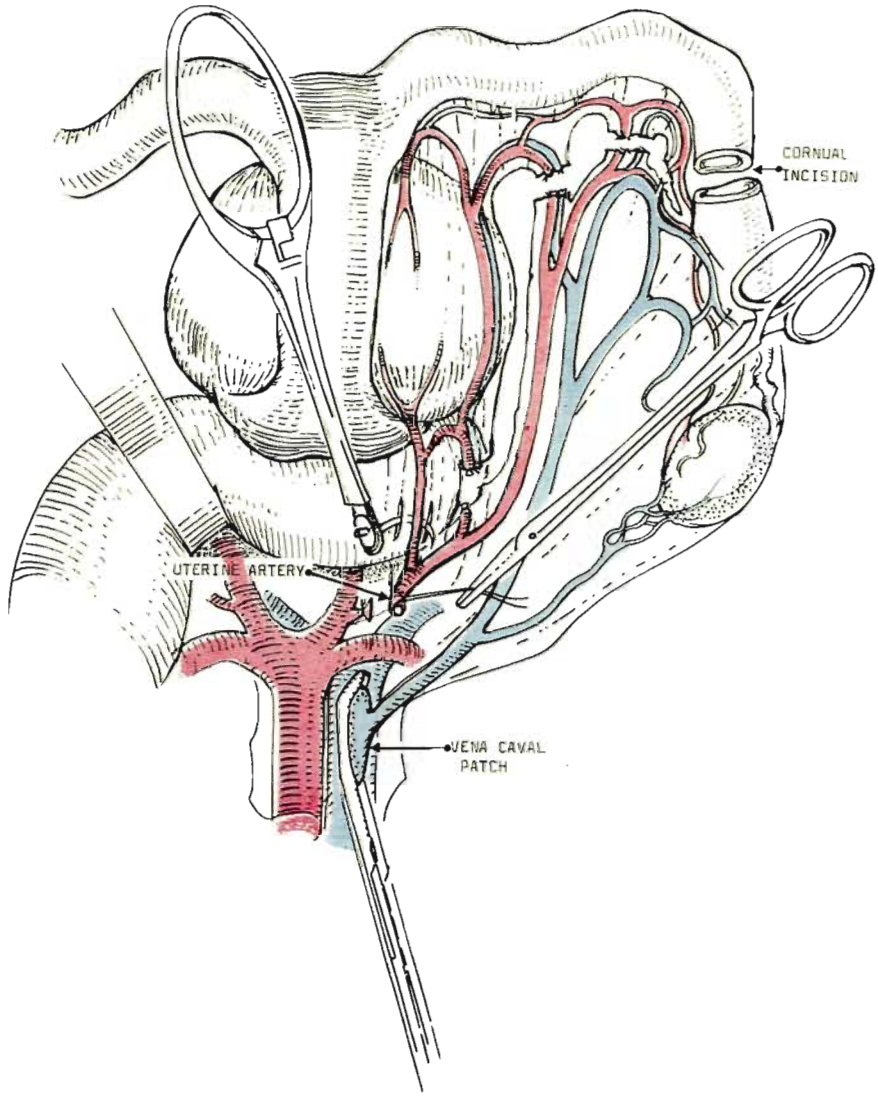

Fig. 4. Application of vena-caval clamp prior to removal of vena-caval patch.

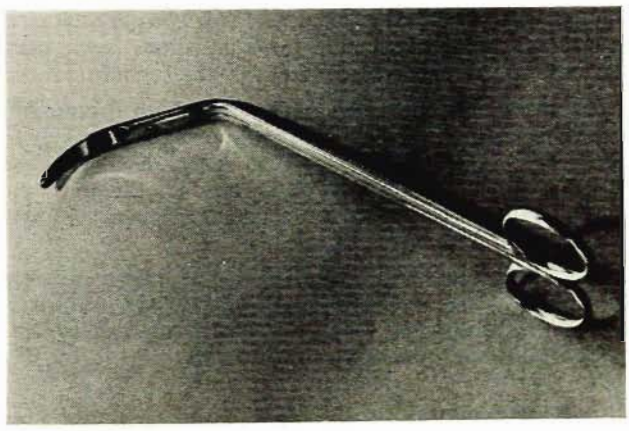

Fig. 5. Scissors for excision of vena-caval patch. (Designed by A. Schweickhardt, Tuttlingen, Germany.)

The ovarian vein was transected in the pelvis approximately 2 cm within the pelvic brim, and the uterine artery was transected at the level of the isthmus of the uterus. The donor ovarian vein was re-anastomosed to the ovarian vein of the recipient. This end-to-side anastomosis was completed with 6 - 0 silk on a fine atraumatic needle. The donor uterine artery was anastomosed to the recipient uterine artery at the level of the uterine isthmus after its distal segment had been ligated. This anastomosis was completed in a terminal side-to-side manner with 6 - 0 silk, as shown in Fig. 11.

DISCUSSION

Surgery of the oviduct for infertility has given such disappointing results that many gynaecologists do not

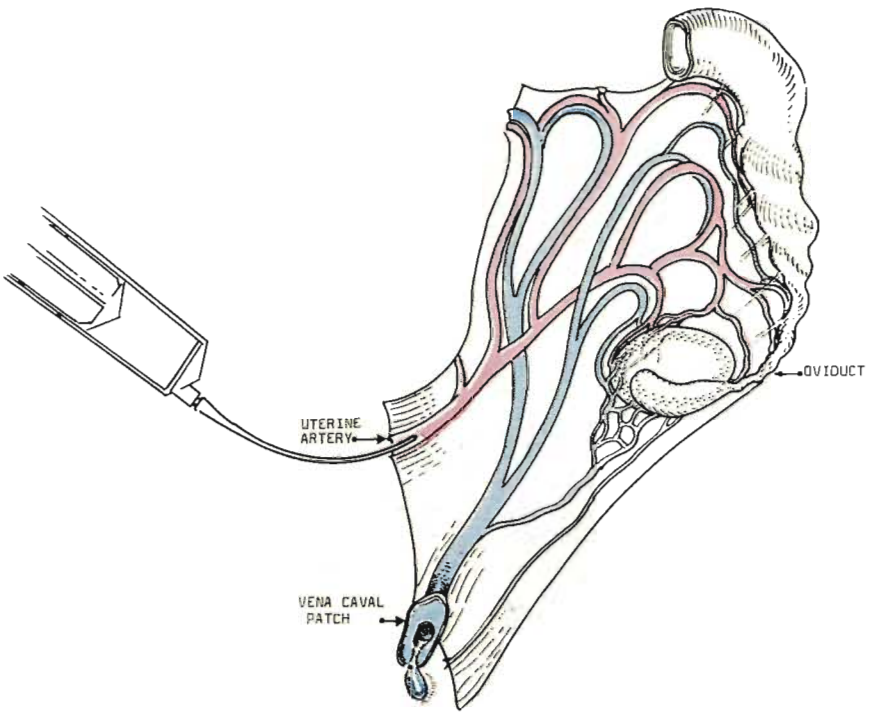

Fig. 6. Diagram showing perfusion of vascularised transplant specimen.

practise it at all.[2] Where the Fallopian tubes have been extensively damaged, the prognosis as regards a normal pregnancy is extremely poor. The Fallopian tube is not a simple conduit, and each and every part of its structure has an important complex physiological function.[3,4]

Efforts to replace or bypass the oviduct have included: (*i*) implantation of the ovary directly onto the uterine cavity;[5,6] (*ii*) substitution of the oviduct by autotransplantation of a segment of ileum,[7-9] the vermiform appendix,[10] arterial or venous grafts,[11,12] a peritoneal tunnel[2] or a Silastic artificial tube;[13] and (*iii*) extracorporeal fertilisation of ova with spermatazoa with a view to re-implanting the developing morula into the uterine cavity.[14] To date, these procedures have proved extremely disappointing.

Another method to be explored is total replacement of the structure by a healthy functional homograft. This concept is not new, and non-vascularised homograft transplantation of the Fallopian tube in the human female was recorded in the literature by Ritala in 1946.[15] Other authors[2,16] later commented on this approach to the problem.

While many workers have recorded transplantation of the uterus together with its appendages,[17-22] no reference could be found which applied specifically to a technique for vascularised transplantation of the Fallopian tube.

Homograft transplantation of this structure would have its main clinical application in current gynaecological practice. The technique described conforms to the normal flow of blood from the uterine artery to the Fallopian tube and venous drainage through the ovarian vein.

A simple modification of this technique, as described in the sheep (*vide supra*), could well be applied in the human female. Use of the ovarian vein as the site for the venous anastomosis would avoid the formidable hazard of working on the vena cava. An abundant source of fresh donor material is available, since about twenty abdominal hysterectomies are performed for every case submitted to conservative tubal surgery,[23] and many of these patients have normal, healthy Fallopian tubes.

Oviduct transplantation would not raise ethical objections, since the structure would be used as a physiological conduit enabling conception and nidation, and there would be no transfer of germ cells to the recipient.

Preliminary, unpublished experience with homograft transplantation of the vagina and the ovary in the human female has been favourable. Further work on vascularised transplantation of the Fallopian tube is essential, and many immunological as well as endocrinal problems will have to be solved.

It is thought that the technique described will form the basic strategy for successful vascularised transplantation of the Fallopian tube, and that it may yet become applicable in the human female.

I wish to record my grateful thanks to the following institutions and people who have made major contributions to this project in one form or another: the South African Medical

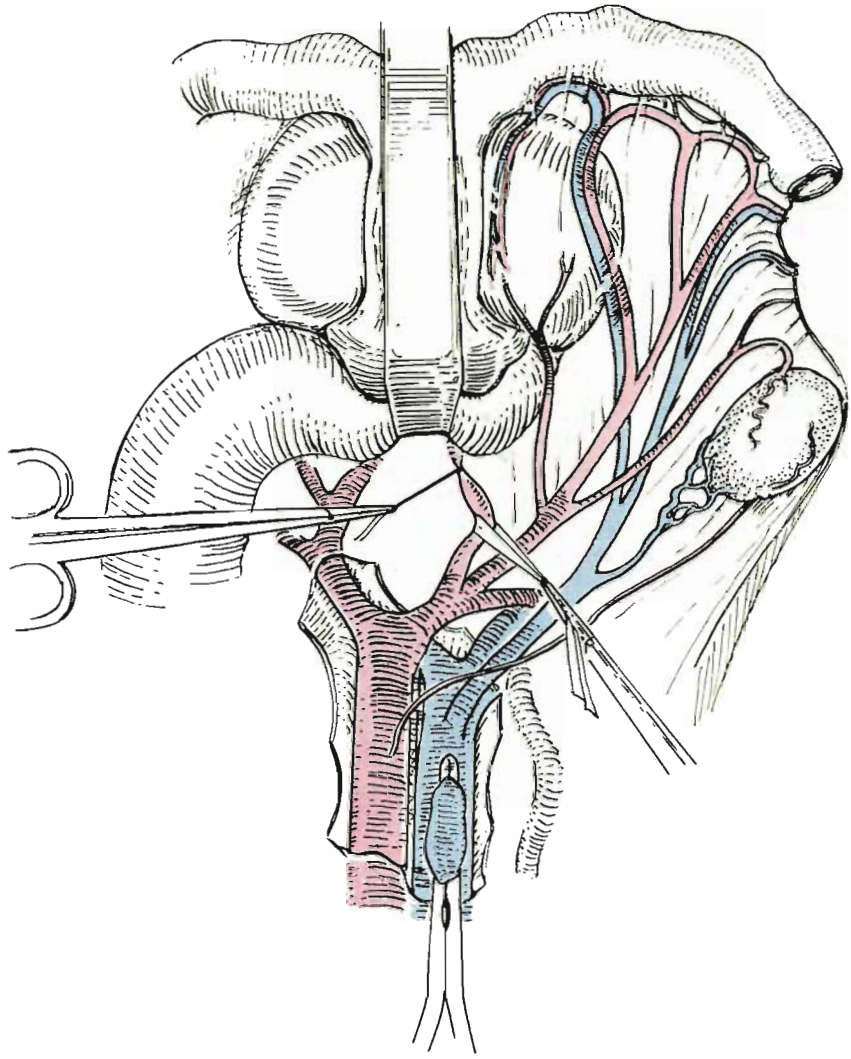

Fig. 7. Oviduct excised and dissection of recipient completed. Note the mobilised pudendal artery and application of vena-caval clamp.

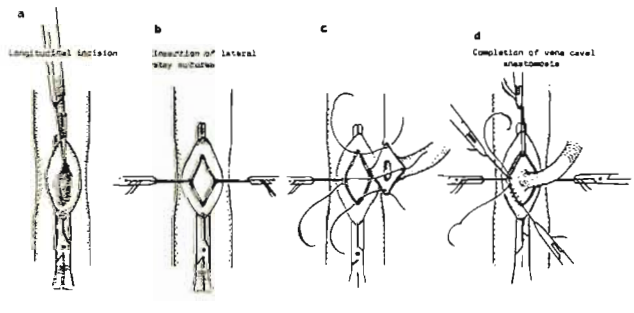

Fig. 8. Preparation of recipient vena cava.

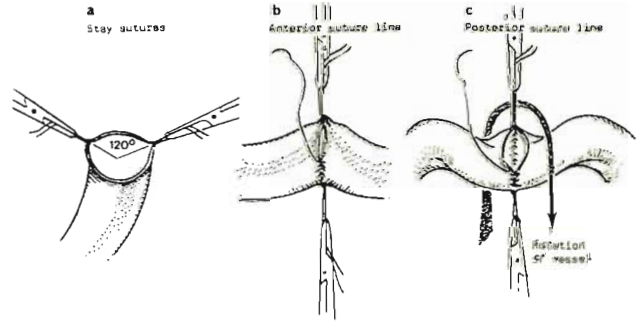

Fig. 9. Technique of completion of arterial anastomosis.

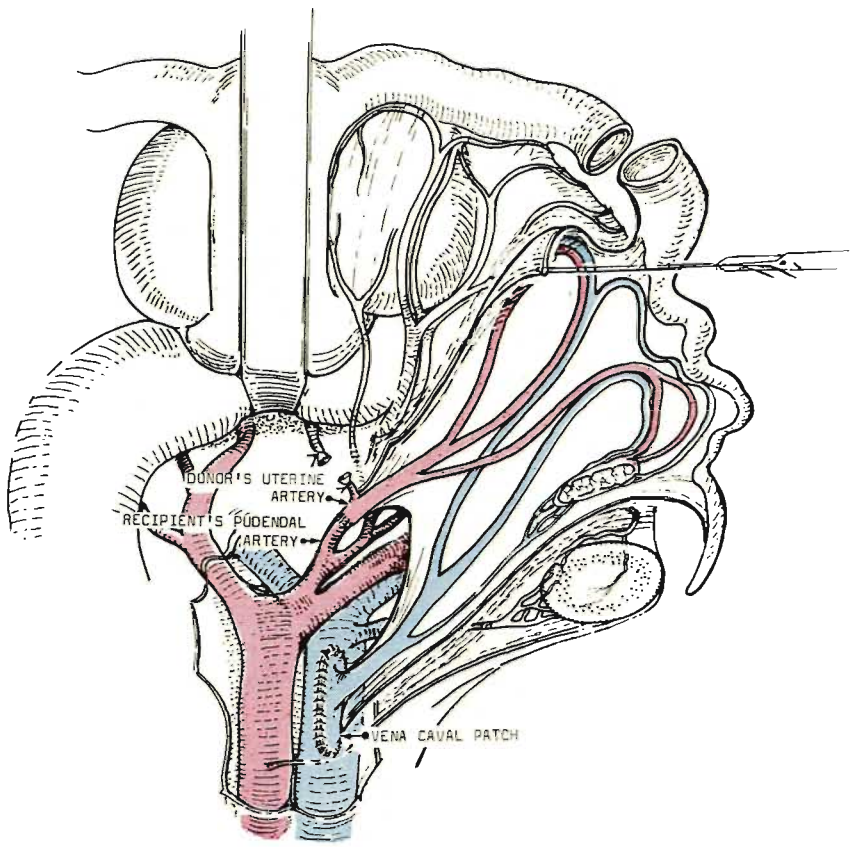

Fig. 10. Transplanted oviduct *in situ*.

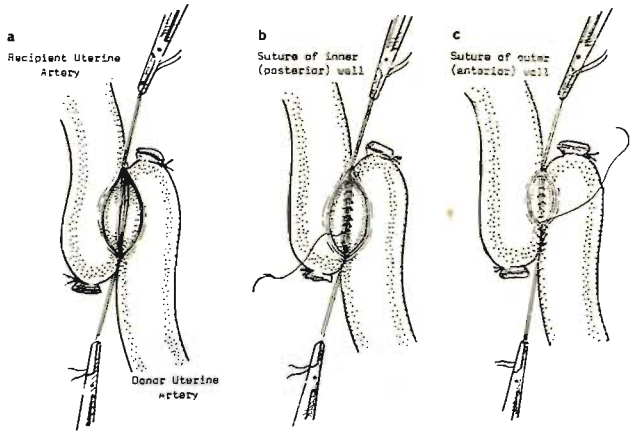

Fig. 11. Technique of terminal side-to-side arterial anastomosis.

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