Preparation of renal autotransplants in sheep

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Contemporaneous access to the renal blood vessels and the ureter is vital for many studies which examine the physiological functions of the kidney. With the difficulties in long-term maintenance of indwelling cannulae, when the organs and vessels are in situ, it was decided that transplantation of the kidney to an accessible site may be a preferred solution. This paper describes the surgical procedure involved in autotransplantation of the right kidney to a cervical site in the sheep.

Methods and Results. The procedure required four separate surgical stages:

Stage 1—Exteriorization of carotid artery and jugular vein and preparation of tissue bed to receive kidney. Young mature Merino crossbred ewes were selected for adequate skin redundancy for preparation of vascular loops, for normalcy of renal anatomy by IVP, and for absence of urinary tract infection. Anesthesia was induced by pentothal and maintained by halothane/oxygen. Three vertical incisions were made from the line of the caudal edge of the right mandible; the dorsal two were up to 12 cm long and the anterior 8 cm long and 2.5 cm apart. The right carotid artery and jugular vein were dissected free, their tributaries tied and divided to provide a length of vessel sufficient to lie in the skin tubes. A kidney-profiled disc (Lucite®) was placed subcutaneously over the right parotid, with its upper edge just below the ear, and sutured through the deep fascia at the poles. The two skin tubes were sutured to enclose the artery in the posterior and the vein in the anterior.

Stage 2—Exteriorization of parotid papilla. Four to six weeks after stage 1, a right-side Wright parotid fistula was prepared [1]. The contralateral carotid artery was exteriorized, and the sheep was bilaterally oophorectomized. The animals subsequently maintained themselves in sodium balance by drinking sufficient 0.3 M NaHCO₃ solution also containing 0.08 M Na₂HPO₄, to offset the salivary sodium and phosphate loss. A minimum of 6 to 8 weeks was allowed for the animal to recover prior to the next operative procedure.

Stage 3—Autotransplantation of right kidney. At the cervical site a transverse incision was made from the base of the parotid fistula skin tube to the dorsal pole of the plate (Lucite®), cutting the superficial skin of the tubes of the vessels at their cranial ends. The capsule around the plate was incised along its caudal edge, and the plate was removed. The skin tubes were incised for 1.5 cm and the jugular vein and carotid artery dissected cleanly to give a free 2-cm length of vessel. Then, they were tied as far cranially as convenient. The parotid duct was found under the anterior run of the incision and dissected free. The secretomotor nerve which runs with the duct was identified and divided as far orally as possible and was avulsed from the gland. At the lumbar site a subcostal oblique incision was made. The right renal artery and renal vein and the right ureter were dissected cleanly, taking care to preserve the ureteric blood vessels. When these dissections were finished 7000 U of heparin were given intravenously.

The renal artery and vein then were divided as close as possible to the aorta and vena cava and the ureter was cut 15 cm from the renal pelvis. The vessels were perfused with ice-cold Ross solution (Intramel, Spearwood, Australia) to which 4 ml/liter of 5% procaine hydrochloride (David Bull Laboratories, Melbourne, Australia) was added. The portion of the renal artery which had been traumatized during perfusion was cut off cleanly. Bowel clamps were placed on vascular loops and the artery and vein were divided near the ligatures and the vessels washed clear of blood with heparinized saline.

At the cervical site the kidney was oriented with the pelvis pointing toward the nose and the kidney mass in the "pocket" (Lucite®). The carotid artery and the renal artery were matched for length and rotation and sutured end-to-end withatraumatic 5/0 silk with three locks in a continuous seam. The renal vein and jugular vein were treated similarly. Shortly after the start of the venous suture, infusion of 20% mannitol in water was commenced at 2 ml/min into the left jugular vein. As soon as both vessel sutures were finished, the bowel clamps were taken off and any visible leak was stopped. The kidney suffused immediately and in a few minutes the pelvis and ureter demonstrated peristalsis and urine expulsion.

The ureter was then drawn forward to moderate tension and was cut transversely 1 cm behind the base of the skin tube of the fistula. The parotid duct was then cut at a corresponding point and the glandular end ligated. A plastic tube was introduced through the papilla and backward until approximately 4 cm could be introduced into the ureter which was then brought into

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apposition to the duct. Eight 6/0 atraumatic silk stitches were used to draw the two ducts into close contact. The plastic tube was withdrawn 1 to 4 days later.

The kidney was located comfortably in the “pocket” by equatorial incision and enlargement by finger persuasion of this cavity, if necessary. The undersurface of the skin was sutured to the deep fascia to provide a pouch for each pole of the kidney then all skin incisions were sutured with interrupted stitches. A brisk flow of urine was maintained by completing the infusion of 0.5 liter of mannitol followed by 2 liters of 0.15 mole/liter NaCl over the next 24 hr.

Stage 4—Left nephrectomy. One to four days after transplantation, when a steady production of urine by the transplanted organ was evident, the remaining abdominal kidney (left-side) was removed.

Discussion. Renal autotransplantation has been attempted on 11 sheep over a 3-year period. Currently, six animals still survive 2 to 38 months post-transplantation. Three sheep survived for 6 to 7 months, during which time many experiments were performed prior to the onset of hydronephrosis and sacrifice. Only in two animals were there immediate postoperative complications, one animal surviving less than 1 week and dying as a result of thrombosis at the arterial suture line and the second dying as a result of infection 6 weeks after transplantation. Thus the overall success rate is 82% for useable preparations.

Once the animals have recovered from surgery, usually 2 weeks post-transplantation, their renal function was assessed for normalcy [2, 3] and experiments were commenced. Experiments were performed biweekly on average on each individual sheep. Thus, the preparation offers easy access to renal vessels and urine over a prolonged period for experimentation. Physiological assessment shows that the kidneys respond appropriately to challenge with hyper- or hypo-osmotic loads [3], secrete renin normally [2, 3], and are responsive to locally-infused hormones such as aldosterone [4] or AVP [3].

One of the most novel aspects of this preparation is the use of the parotid duct as a continuation of the ureter. The papilla of the exteriorized duct appears to limit bacterial access to the ureter as does the continued ureteric peristalsis. Urine is checked regularly for bacterial contamination and on occasion has been positive. However, all the identified bacteria would be present in an animal laboratory and could have been surface contamination, rather than a urinary infection per se. The other advantage with using the exteriorized parotid duct is the ease of urine collection, as the urine drips directly into a stainless steel tray placed inside the animal’s cage.

In summary, a novel procedure for autotransplantation of a kidney in sheep is presented. The preparation allows frequent simultaneous access to renal arterial and venous blood and to urine and has shown an overall success rate of 82%. Bacterial infection is minimal and the kidney reinnervates and responds normally to renin-active hormones and to physiological changes.

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