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Permanent contraception by laparoscopic tubectomy with ovarian conservation in Hong Kong macaques

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Abstract

Between 2009 and 2019, 1,343 laparoscopic tubectomies were carried out in field conditions in Hong Kong Macaques (*M fascicularis x M mulatta*) through a three-port approach using 3 mm pediatric instruments. This surgery can be completed within 4 to 10 minutes through 3 mm entry points. No post-surgical care is required. All the animals recovered uneventfully and were returned to the wild within 6 hours post-surgery.

Field observations during 2,169 survey days spanning 10 years (2009-2019) did not reveal any surgical complications including sepsis, suture-picking, herniation or evisceration. Laparoscopic tubectomy with ovarian conservation is a rapid and simple procedure that can be carried out in the field, requires no follow up, has fewer potential complications than open surgery and preserves hormonal integrity essential in active and long-lived social primates. This technique is recommended as a method of choice for permanent sterilization of wild macaques and other primates.

Key Words: contraception, laparoscopic tubectomy, macaque

Introduction

Rhesus macaques (*Macaca Mulatta*) were introduced to the Kowloon Hills (Hong Kong) around 1910 [19]. Long-tailed macaques (*M. fascicularis*) were later released to the same areas in the 1950s [19]. Both species have interbred back and forth to produce the Hong Kong macaques presenting combined traits of both founding species [19]. Hong Kong macaques are fully protected under Hong Kong law.

Ongoing human encroachment, increased food availability due to public feeding and improper management of domestic refuse created human-macaque conflictual interfaces. Over-abundance of food also contributed to rapid increase of macaque population [19].

The Hong Kong relevant authority's Agricultural, Fisheries and Conservation Department (AFCD) conflict management plan includes reducing the fertility of the macaque population by using contraception.

Mass capture of wild macaques is expensive and time consuming. Therefore, it is advisable to choose a contraceptive method that is reliable and irreversible. A fertile female macaque typically produces 0.5 to 0.6 young annually for two decades [17, 18]. To effectively reduce the birth

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Fig. 1. Small squeeze cage connected to the communal trap

rate in a population, sterilization of females is preferred to sterilizing males. Sterilization of males cannot be relied upon to significantly decrease population growth in macaques because females will mate with multiple males. As is the case for other primates, breeding activity and social rank of males are not reliable indicators of true paternity [2, 5, 9, 10, 14, 15, 16].

When contemplating conventional open surgery, post-surgical monitoring and the ability to intervene at short notice are necessary because complications due to mutual and self -grooming behaviors or suture and wound picking are common in macaques [6]. However; post-operative interventions in wild patients cannot realistically be envisaged. Long term holding of wild macaques for post-surgical observation is impractical and detrimental to the animals due to stress and fighting wounds resulting from close confinement in unfamiliar surroundings.

Laparoscopic tubectomy is a preferred surgical option as it requires no post-surgical care thanks to minuscule entry points with almost nil opportunity for picking sutures, herniation or evisceration. Maintaining ovarian integrity is a superior option. This study describes the technique and its application over 10 years and 1,343 surgeries in the field.

MATERIALS AND METHODS

Capture and pre-operative processing

Population survey and trap habituation were carried out on 2,169 days between 2009 and 2019. Groups of 15 to 129 macaques were trapped in communal traps (3m wide by 6m long by 2m tall). Trappings were carried out 10 to 24 times a year between 2009 and 2019. A movable partition inside the communal trap is used to repeatedly drive smaller groups of 1 to 4 animals into a small squeeze cage (fig. 1), where they are injected with

an anesthetic cocktail. A thorough pre-anesthetic medical examination complete with clinical laboratory data is unobtainable when working on wild animals in the field.

Medetomidine (Dorbene®, Laboratories Syva, Spain) 0.05 mg/kg and ketamine (Ketamine®, Alfasan International BV, Holland) 5 mg/kg were mixed in the same syringe and injected intra muscular in the brachial or femoral muscles. During surgery, anesthesia was maintained with Isoflurane (Attane®, Piramal Critical Care Inc, USA) 1.5% delivered via a pediatric face mask using an open circuit. Anesthesia was reversed with intra muscular atipamezole (Alzane®, Laboratories Syva, Spain) using a dose of 5 mg atipamezole / mg of medetomidine.

Pre-operative examination and abdominal palpation help detect masses, hernias and palpable pregnancies. Macaques with palpable pregnancies are not suitable surgical candidates.

A single dose of 20 mg/kg of the antibiotic Amoxycilline (Amoxycilline 20% LA®, Alfasan International BV, Holland) and 2 mg/kg of the non-steroidal analgesic Carprofen (Rymadil®,Zoetis Petcare, USA) were given preoperatively.

Fig. 2. Positioning the macaque on a foam wedge to keep the pelvis elevated. The surgical area is shaved from the flanks to 2-3 cm above the umbilicus and to the pubis

Surgical Technique

A rectangular area, starting 2-3 cm above the umbilicus and extending to the flanks and the pubis, is clipped and prepared aseptically for surgery.

The macaque is placed in dorsal recumbency with its pelvis elevated above the head using a foam wedge. The hind limbs are secured to the wedge using Velcro straps. This position allows the intestines to fall forward to expose the uterus; uterine tubes and ovaries. The arms are positioned loosely alongside the body. The TV screen is positioned facing the back end of the monkey (fig. 2).

A 3 mm skin incision is made immediately below the umbilicus. A Veress needle is inserted through the linea alba and the abdomen is inflated with medical grade carbon dioxide (CO_2) to a pressure of 12 mmHg.

The Veress needle is removed and a 3 mm lightweight plastic short cannula with outer thread (Storz 62114GK) is placed through the same track. A 3 mm 0° telescope (Storz Hopkins II 7220AA) is inserted through the cannula.

Two other 3 mm skin incisions and stab wounds of the underlying abdominal wall are made laterally and caudally to the telescope along an imaginary line connecting the port for the telescope and the iliac crest. These are used to pass the operating tools without cannulas. This port placement allows good triangulation and easy access to the oviducts. The abdominal wall is thin therefore trocars are not required for the forceps (fig. 3).

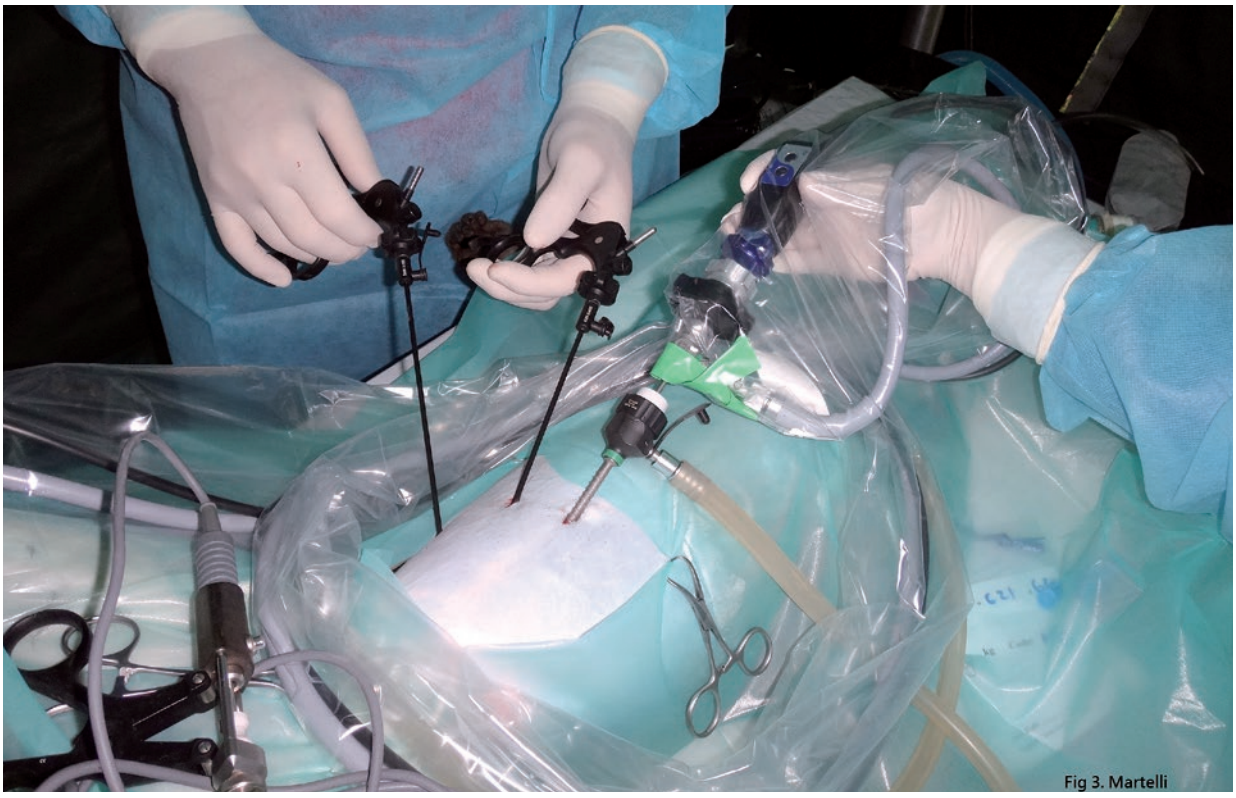

Fig. 3. Position of the instruments and camera allowing the surgeon to work from one side and the surgical assistant to hold the camera

The uterus is clearly visible in the pelvis as a red spheroid organ. The uterine tubes ending in the fimbriae and the ovaries are visible lateral and cranial to the uterine body (fig.4). The reproductive tract is examined for anomalies.

The uterine tube is grasped using a 3 mm 20 cm long curved grasping forceps (Storz 30321MDS Clickline Kelly forceps) introduced through the middle port. A suitable portion of the tortuous uterine tube is presented to the bipolar electro-coagulation forceps (Storz 26184HCS, Take-Apart MANHES Bipolar Coagulation Forceps), introduced through the distal port. After cauterization of a segment 0.5 to 2 cm long, the bipolar forceps are removed and replaced by serrated curved scissors (Storz 30321MWS Click Line Scissors) for resection of the cauterized segment of the uterine tube. The operation is repeated for the contralateral homologous structure.

After both uterine tubes have been interrupted, all instruments are removed, and the abdomen is gently deflated. The linea alba is sutured using one simple absorbable suture. The muscle layers at the other 2 ports are not sutured. Skin incisions are glued shut (3M surgical glue).

After surgery the macaques are identified using a sub cutaneous passive transponder tag (FriendChip, Avid Identification Systems Inc, USA) as well as a tattoo on its chest and are then sent to the recovery station (fig. 5). Three to six juveniles, sub-adults and adult females are placed in smaller cages and injected with atipamezole. Once sufficiently recovered from anesthesia the macaques are transferred back to the communal trap. Food and water are offered in the communal cage. Large males are recovered separately in individual cages. All macaques are released on site, the same day.

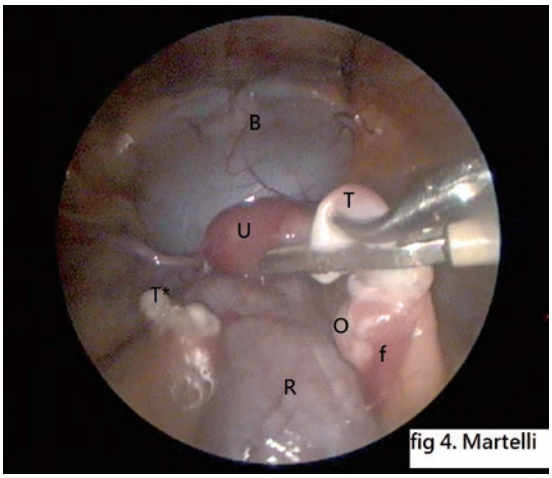

Fig. 4. Intraoperative view. B: bladder, R: rectum, U: uterus, T: right uterine tube, O: right ovary, f: right fimbriae, T* resected left uterine tube

Fig. 5. Macaques at the recovery station. Note the smaller recovery cages in the background

RESULTS AND DISCUSSION

Between 2009 and 2019, 1,343 laparoscopic tubectomies with ovarian conservation were performed on female macaques in Hong Kong country parks. The macaques' body weight ranged from 1.8 to 12.8 kg. The duration of the procedure from incision to skin closure averaged 5 minutes and ranged from 3 to 10 minutes, depending on operator experience, the abundance of intra-abdominal fat, pre-existing adhesions or other anatomical and pathological variations and equipment malfunction.

Vessel sealant tools were tried. These tools do not yet exist in 3 mm sizes, only in 5 mm. Our team found that the seconds saved in replacing the bipolar forceps with the scissors were not worth the difficulty of handling a larger instrument in a small cavity or the trade-off of creating a larger incision requiring suturing of the instrument port.

Wild macaques regularly presented with pre-existing traumatic abdominal hernias, peritoneal adhesions and varying degrees of chronic peritonitis or ascites, but these rarely complicated the procedure significantly or noticeably affected recovery.

Macaques with palpable pregnancies are not suitable candidates for laparoscopic tubectomy surgery. The gravid uterus comes to rest on top of the uterine tubes and ovaries making visualization and access cumbersome and increasing surgical time and risk. Nine early pregnancies were suspected during laparoscopy based on the presence of mildly rounded, congested and enlarged uteri with corresponding ovarian signs of recent ovulation (corpus hemorrhagicum or corpus luteum). These animals underwent the same laparoscopic tubectomy. To our knowledge three macaques completed the gestation successfully. The others did not but remained in apparent fine health. As we were unable to confirm pregnancy and we lacked knowledge of the rate of early pregnancy failure in the natural population, we were unable to draw worthwhile conclusions.

A good visualization of the reproductive tract is of a paramount importance to perform a tubectomy. Occasionally, particularly loose mesenteric membranes cloaked the telescope and gentle maneuvering of the telescope and forceps was required to expose the pelvic cavity for good visualization of the reproductive tract.

Another common cause of visual obstruction of the uterine tubes was a full urinary bladder. This was easily resolved by emptying it trans-

abdominally under endoscopic visualization. On very rare occasions, macaques with severe pre-existing adhesions had to be excluded as non-suitable candidates for laparoscopic tubectomy. Obese animals were rarely encountered in the wild but presented no particular laparoscopic tubectomy challenge.

Maintaining ovarian integrity is a superior option. Many behaviors and the integrity of organ systems indispensable to the socially complex and physically demanding existence of wild macaques are under the influence of sex hormones. Increased bone turnover and myocardial disease are documented in ovariectomized humans and macaques [7, 11, 12, 13]. In humans and their macaque models, sterilization with ovarian conservation has positive effects on survival [11], reduces the incidence of myocardial infarction [11,12], and maintains the integrity of the long bones and rachis [1, 3, 4, 8, 11].

Laparoscopic tubectomy leaving the ovaries in place leads to permanent infertility without demonstrable endocrine change [20].

The macaques were trapped in their home range and they were released on site, on the same day after a full recovery from anesthesia. In order to prevent fighting injuries and unnecessary stress we advocate against keeping them in captivity for post-surgery observation. Juveniles, sub adults and female macaques were recovered together in the communal trap and released as a group. Large males are inclined to bite females and young, to express frustration and affirm status. Large males were recovered in individual cages and released along the rest of the group.

Upon recovery macaques invariably started eating, drinking, playing and grooming inside the communal trap waiting for release. To date, daily monitoring by the surveyors have not recorded any post-surgical complications or concerns. Macaques were monitored for periods ranging from 6 months to 10 years post-surgery, paying close attention to surgical or social complications relating to the procedure. No complications were noted and none of the monitored or recaptured females were found gravid. Birth rates of total population of Hong Kong macaques fell from just under 60% to 30% during 2009-2019.

Monitoring is ongoing and will foreseeably continue for the next 2 to 5 years.

Forming experienced support teams for trapping, anesthetizing, preparing, recovering and returning macaques to the wild was essential for a seamless, efficient operations with minimal to zero animal and human mishaps. A proficient team was able to surgically process 4 to 11 macaques/hour. Other field realities such as weather, technical issues and locality also contributed to determining the number of animals that can be operated on and how rapidly.

In conclusion, we recommend laparoscopic tubectomy with ovarian conservation as the preferred choice of permanent sterilization for wild macaques and other free-ranging primates. It can be performed in most field conditions, significantly reduces the need for follow up and presents little concern for surgical complications.

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