Alexandria Journal of Veterinary Sciences
www.alexjvs.com

AJVS. Vol. 56 (2): 123-130. Jan. 2018
DOI: 10.5455/ajvs.292324

Bipolar Electrocautery Versus Clipping Endo-Hemostasis during Laparoscopic Castration in Lateral Recumbent Horses

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Key words:
clipping, castration, electrocautery, horse, laparoscopy

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ABSTRACT

Principal contest of laparoscopic castration is achieving optimal endo-hemostasis of the testicular blood vessels. The present study was designed to describe and compare two endo-hemostatic techniques; electrocauterization and clipping in lateral recumbent horses. The study was performed on eight horses admitted for routine castration. Multiple technical difficulties associate bipolar electrocauterization technique such as impairment of visibility of the surgical field due to engendered smoke, the necessity for frequent cycles of coagulation-transection, bleeding from improperly coagulated vessels and tissue carbonizing. These difficulties increased the surgical time and decreased the feasibility of the procedure. Meanwhile, Clipping endo-hemostatic technique especially Multi-Fire clipping is advisable as a safe alternative procedure for elective laparoscopic castration in lateral recumbency. It has the superior hemostatic capabilities coupled with simple technical feasibility; two ports, one surgeon and scored the minimal operative time and no intra-operative complications.

1. INTRODUCTION

Laparoscopic castration techniques of both cryptorchid and normal descended testicles are becoming widely accepted because of the reported advantages including better visualization of important structures during surgery, tension-free occluding of vessels, reduced pain and/or morbidity during the postoperative period, faster patient recovery, and better cosmetics results after surgery (Hanrath & Rodgerson, 2002; Hendrickson, 2006; Hendrickson, 2012). Compared with the conventional surgical field, the laparoscopic surgery presents unique technical challenges even with the experienced surgeon that include low depth perception, limited working space, and impaired visibility through different light absorption, smoke, fogging of the laparoscope lens, or blood on the lens (Berguer et al., 1999; Schurr et al., 1996; Shah et al., 2003; Tendrick & Jennings, 1996; Wentink, 2001; Xin et al., 2006). The chief challenges with laparoscopic castration technique are finding the best way to provide efficient hemostasis (Aziz et al., 2008; Hanrath & Rodgerson, 2002) and finding better patient's position to improve intraoperative field view and working space of important structures (Galuppo et al., 1996; Hendrickson, 2006; Hendrickson, 2012; Rubio-Martínez, 2012; Wilson et al., 1996). The choice of patient's position and device for dissection and hemostasis during laparoscopic surgery is generally according to device availability and experience of the surgeon. Laparoscopic castration is performed in standing position (Davis, 1997; Hanrath & Rodgerson, 2002; Hendrickson & Wilson, 1997), dorsal recumbency (D. Hendrickson, 2006; Wilson et al., 1996; Wilson, 2000), and lateral Trendelenburg position (El-Sherif, 2013; El-Khamary et al., 2016). The lateral Trendelenburg position provides a direct panoramic visualization of the surgical field, minimizes the risk of pneum-hemodynamic consequences, and offers a comfortable instrumental handling for the surgeon (Hofmeister et al., 2008). Variable tools and methods are designed to induce hemostasis during the laparoscopic procedure such as Laser techniques (Palmer, 1993), Ultrasonic shears (Alldredge & Hendrickson, 2004), Harmonic Scalpel (Düsterdieck et al., 2003), Stapling instruments (Doran et al., 1988), ligature application (Boure' et al., 1997), vascular clips (Rodgerson et al., 1998), and electrocoagulation (Hanrath & Rodgerson, 2002; Rodgerson et al., 2001). Although Ultrasonic shears, Harmonic Scalpel, and stapling instruments are superior to vascular clips and electrocoagulation in terms of safety, they are not universally available in teaching hospitals and very expensive. Additionally, ligature technique has many limitations such as time-consuming, difficulty in applying, ligature slippage (Fischer & Vachon, 1998; Ragle & Schneider, 1995; Rodgerson & Hanson, 2000). Hence, there is a crucial need to describe and compare bipolar electrocautery with clipping endo-hemostatic techniques for intraoperative technical feasibility, and safety of laparoscopic castration in lateral recumbent horses.

2. MATERIALS AND METHODS

2.1 Animals and preparation

The present study was performed on eight horses (6-8 months), weighting (110-140) kg, all horses were healthy and submitted for castration to avoid unwanted masculine behavior through 2014 to 2017. Food was withheld 36 hours prior surgery and the flanks and ventral abdomen were clipped and prepared for aseptic surgery. All horses received sedative (Xylaxine; Xylaject, ADWIA Pharma, Egypt, 0.5 mg/kg) administered intravenously, then, generally anesthetized with ketamine; Ketamine 5%, Sigmatech Pharma, Egypt, 2.2 mg/kg) administered intravenously. Anesthesia was maintained with repeated half dose bolus when required via intravenous rout according to Staffieri & Driessen, (2007).Horses were restrained and positioned in right lateral recumbency and secured to the surgery table with the left hind limb abducted and elevated outward. Infiltration of 10 ml of local anesthetizing solution (Lidocaine; Depocaine 2%, DEPIKY PHARMA, Egypt) into two points; umbilicus (Main port) and ventral inguinal region (secondary port) according to El-Sherif, (2013) and El-Khamary et al., (2016). Standard laparo-insufflation was created to maintain sufficient intraabdominal space for surgery. Main port (MP) 10-mm cannula was introduced via an incision through the umbilicus and used to incorporate the laparoscope. Ten mm secondary portal (SP1) cannula was inserted into the abdominal cavity at the ventral inguinal point 7 cm caudal and lateral to the main port (Fig. 1A and Fig. 2A). The abdominal and pelvic cavities were explored, and the two inguinal rings and their structures were located (Fig.1B and Fig. 2B).

2.2. laparoscopic castration techniques.

2.2.1. Three ports bipolar electrocauterization technique:

The present technique was applied in four horses. A third port (SP2) at the midline and 5cm caudal to the main port was needed (Fig. 1A). A 10mm Allis grasping forceps were inserted through SP1 to tract the mesorchium and vas deferens away from the abdominal wall (Fig.1C&D). A ten mm bipolar forceps were inserted through the SP1 and placed across the mesorchium approximately 1cm proximal to the inguinal ring. The testicular blood vessels were coagulated by applying frequent jets of high frequency (25 watts) bipolar current until blenching, complete desiccation and appearance of white color (Fig. 1E). The bipolar forceps were removed, and 10 mm scissors was inserted to transect the coagulated tissue. Coagulation and transection cycle were repeated sequentially to the vas deferens. The pedicle was examined without tension to ensure adequate hemostasis (Fig.1F). Bipolar forceps were inserted to control any point of further hemorrhage.

2.2.2. Two ports clipping technique:

Laparoscopic castration by clipping technique was performed in four horses according to El-Sherif, (2013) and El-Khamary et al., (2016). Single-Fire clip applier was used in two horses where Multi-Fire endo-clip applicator was used for the other two cases. A 10 mm endo clip applier was inserted through the SP1 and used to apply four medium-large titanium clips over the course of the testicular blood vessels (Fig. 2C&D&E) and two clips over the vas deferens. A proper clipping was ensured when the targeted structure completely enclosed within the clip tips. The clip applier was removed and a 10 mm scissors were inserted to transect the blood vessels and vas deferens between the clips (Figure, 2F).

2.3. Intraoperative evaluation:

Technical feasibility and safety were documented and assessed to compare bipolar electrocautery and clipping endo-hemostatic techniques. Technical feasibility was defined as performance of the laparoscopic castration without much difficulty by using the selected hemostatic technique. Technical feasibility was determined through number of surgeons, ports, instruments, tissue handling, and conflict of hand instruments along with operative time. Operative time was measured in minutes from the time of main port insertion to placement of last skin suture. Tissue handling, and conflict of hand instruments were scored as minimal (1- 3 times), moderate (4-6 times) and severe (7-10 times)

Safety was considered as performance of the procedure without any major complications like bleeding and injury to any viscera. Bleeding was scored according to the scale described by Culp, Mayhew, & Brown (2009) and Dupré et al. (2009); severe grade: the bleeding impaired the observation of the surgical field and required either hemostasis or conversion to laparotomy, moderate grade: the present blood did not obscure the surgical field but required hemostatic intervention, and minor grade: presence of few drops of blood that stopped immediately and required no hemostatic interventions, and none: no bleeding.

3. RESULTS

3.1. Three ports bipolar electrocauterization laparoscopic castration technique:

The bipolar forceps coagulated roughly 3-4 mm of tissue at one time. The process to coagulate the tissue takes from 30 to 35 seconds regarding the amount of tissue within the jaws of the device. Two to three cycles of coagulation and transection were required for testicular blood vessels and one cycle for vas deference and its blood vessel. The mean procedure time (M±SD) was 14±2 minutes (from 12-16 minutes).Generation of smoke occurred during the coagulation impaired the surgeon's visualization. It required intermittent opening of the CO_2 insufflation valve on the laparoscope cannula to improve the laparoscopic visual field (Fig. 3A). In two cases, intraoperative moderate grade hemorrhage from testicular blood vessels occurred after transection of testicular blood vessels without proper coagulation (Fig.3B). Two to three times of coagulation were required for hemostasis of bleeding tissues. Intraoperative hemorrhage from the testicular blood vessels obscured visualizing the operative field.Other recoded technical difficulties were misconduct of bipolar with unwanted structures (Fig.3C), carbonizing, with tissue adherence to instrumental jaw (Fig.3D). Bipolar electrocauterization technique required two surgeons, three ports with moderate tissue handling with minimal instrumental conflict times.

3.2. Two ports clipping laparoscopic castration technique:

Two pairs of medium/ large endo-titanium clips were required to occlude the mesorchium and one pair for the vas deference. Application of clips was easy and there was no need to use another secondary instrument for supporting or grasping the tissues. The medium/ large endoscopic titanium clips were efficient to occlude the testicular vessels. The diameter of the testicular vessels in the equine mesorchium clinically appeared to be less than 1 cm in diameter based on that it was less than one quarter the length of the 2-cm jaw of the clip applier when viewed during laparoscopy. The mean procedure time (M±SD) was 7±3 minutes (from 4 to 10 minutes). In comparison with Single-Fire clip applicator, Multi-Fire clip applier minimized instrument exchange and surgical time through the application of several clips without withdrawal of the device. Clip slippage was not recorded. No intraoperative complications were detected. Clipping technique required only one surgeon, two ports along with minimal tissue handling and no instrumental conflict.

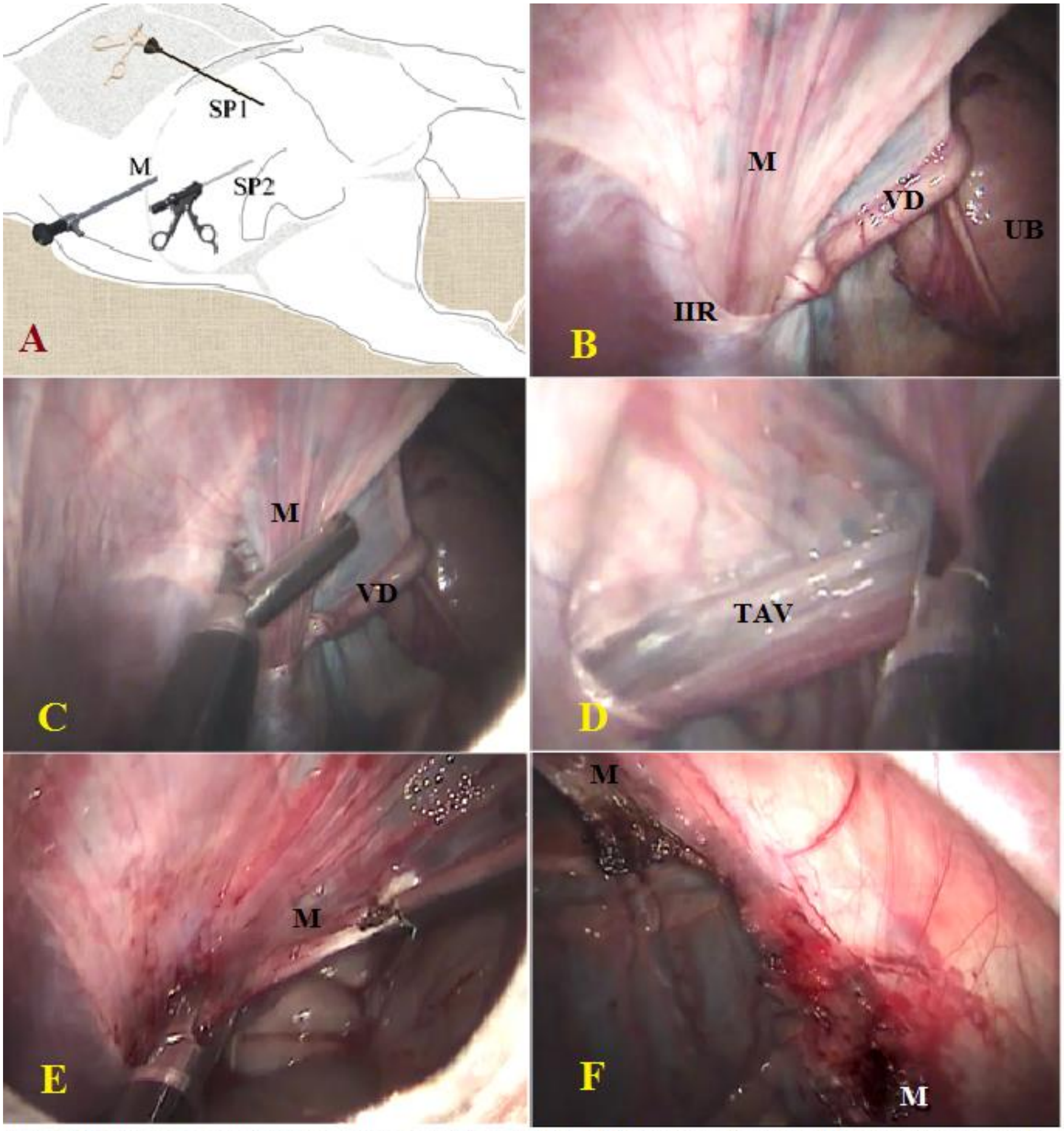

Figure 1: Three ports electrocautery laparoscopic castration. **(A)** Animal positioned in lateral recumbency and three ports were placed, MP; main port, SP1; secondary port for grasper, SP2; secondary port for electrode. **(B)** Laparoscopic anatomy of internal inguinal ring IIR, mesorchium M and vas deferens VD. **(C and D)** grasping of mesorchium. **(E)** Coagulating of the mesorchium. **(F)** Examination of the mesorchium pedicle after transection.

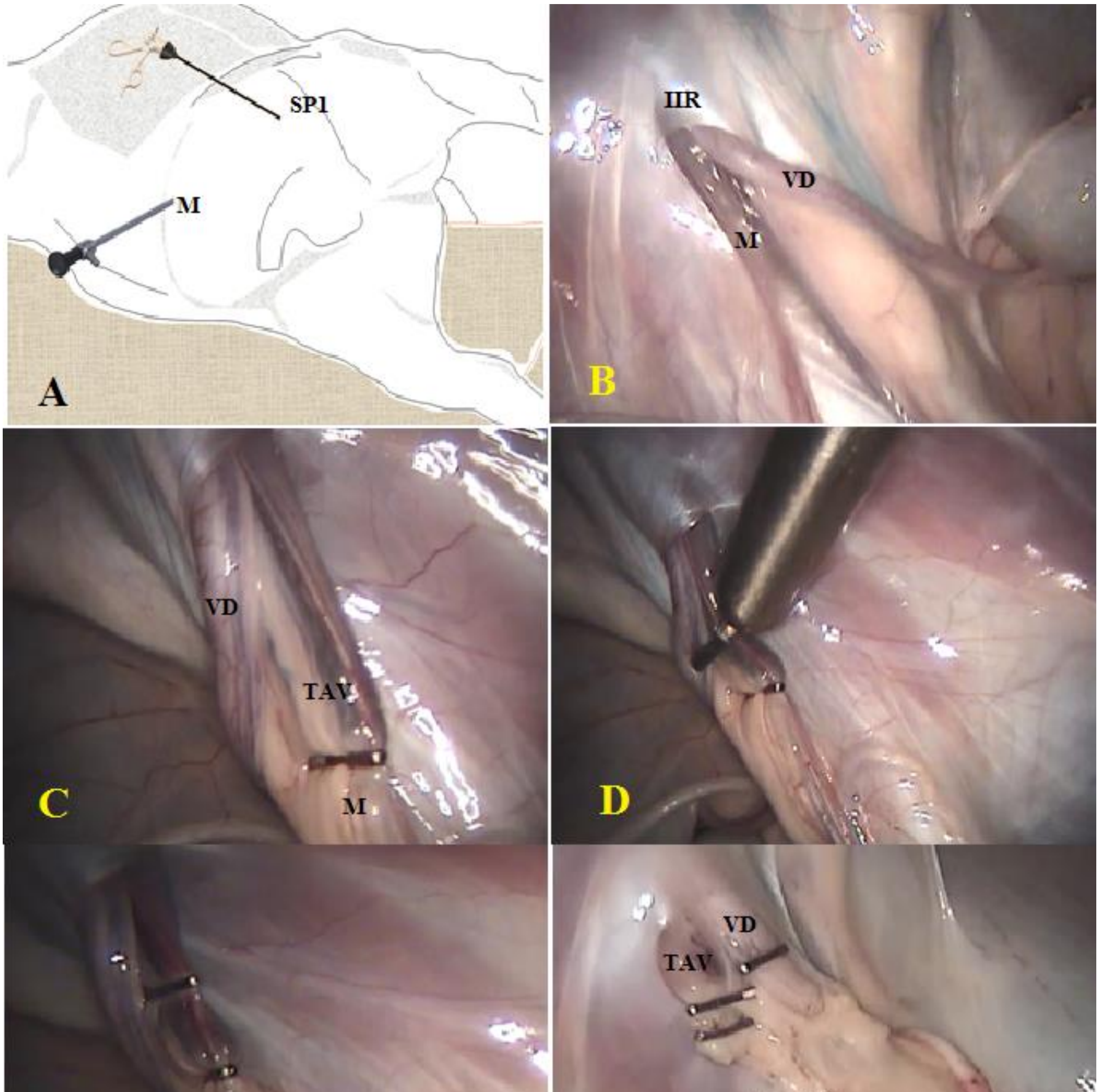

Figure 2: Two ports clipping technique. **(A)** Animal possitioned in lateral recumbency and two ports were placed, MP; main port for laparoscope, and SP1 a secondary port for clip applier. **(B)** Laparoscopic anatomy of the internal inguinal ring IIR showing the vas deferens VD and mesorchium M. **(C, D and E)** Several titanium clips were applied to the testicular vessels. **(F)** Examination of the pedicle after transection.

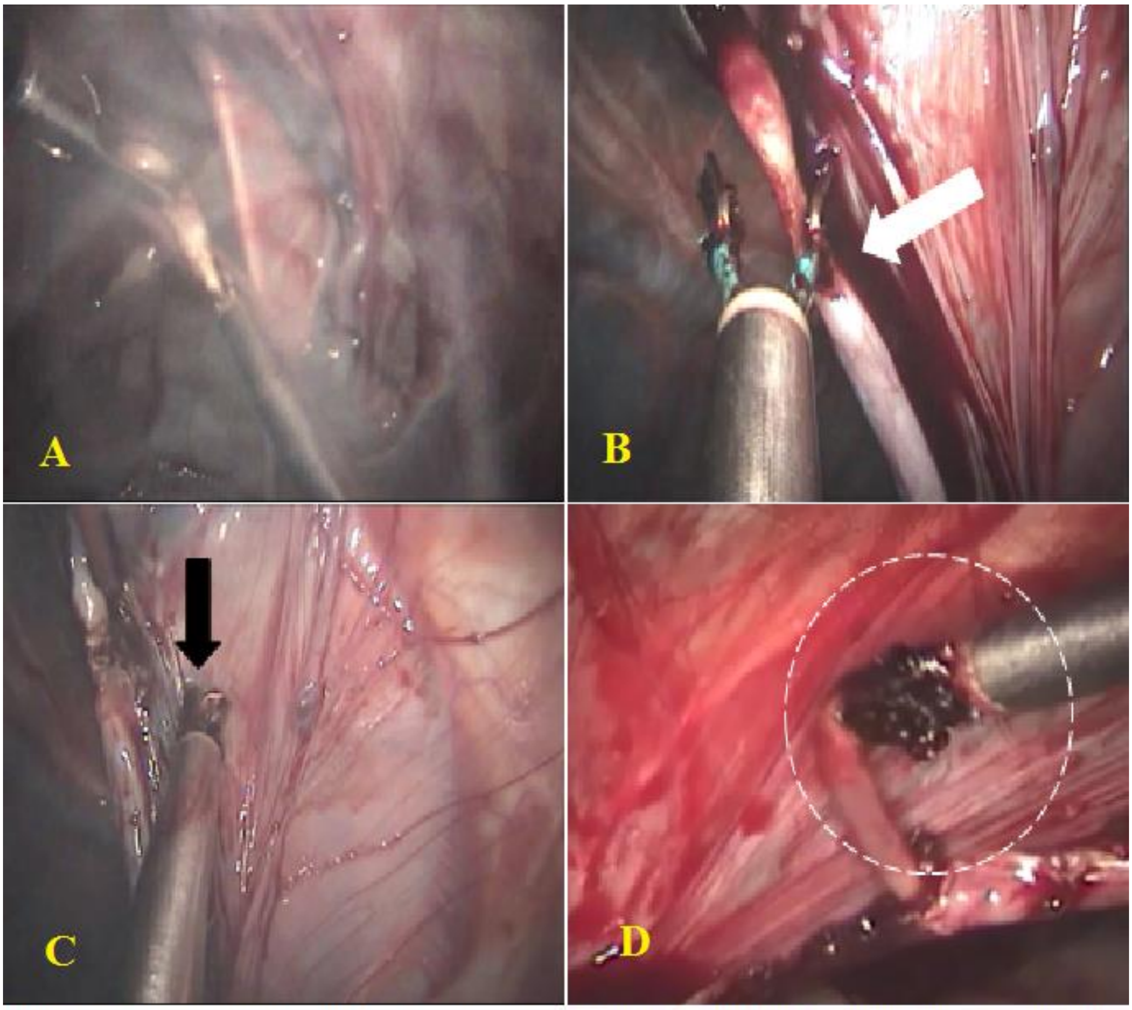

Figure 3: Technical difficulities of bipolar electrocautery. **(A)** Smoking, **(B)** Bleeding from improper coagulated vessels, **(C)** Misconduct of bipolar electrode and **(D)** Carbonizing of the tissue.

4. DISCUSSION

Laparoscopic surgery has become common work specially in the field of equine urogenital surgery. One of the most commonly performed procedure are the laparoscopic castration for cryptorchid or normal descended testicles (Fischer, 2014; Hanrath & Rodgerson, 2002; Hendrickson, 2006; Hendrickson, 2012; Pepe et al., 2005). Primary prevention of bleeding by efficient hemostasis during dissection is a vital principle of laparoscopic surgery (Aziz et al., 2008). With unique technical issues of laparoscopic field, minor bleeding can increase the degree of complexity of the surgery and lead to serious complications. In some circumstance, conversion to an open procedure may be required to control hemorrhage, contradicting the advantages of the laparoscopic approach (Berguer et al., 1999; Schurr et al., 1996; Shah et al., 2003; Tendrick & Jennings, 1996; Wentink, 2001; Xin et al., 2006).

Under most circumstances, the availability of the more sophisticated devices determines their usage. Electrocautery units and endo-clipping are the most common types of hemostatic equipment in the operating room (Alkatout et al., 2012; Newman & Traverso, 1999). The present study was designed to describe and compare the technical feasibility and safety of electrocauterization and clipping hemostatic techniques for laparoscopic castration in lateral recumbent horses.Laparoscopic castration using two ports clipping technique appears more superior technically than the three ports electrocauterization for numerous reasons. Firstly, the application of the clip applier was quick and efficient where the application of bipolar current was sequential, with repeated partial desiccation, and partial transection of the coagulated tissues to minimize the thermal spread through surrounding pelvic tissues and avoid inadvertent severing of incompletely coagulated tissues. These results are in agreement with those obtained by (Gill et al., 2002; Harold et al., 2003; Janetschek et al., 2001; Kennedy et al., 1998; Klingler et al., 2006; Klingler et al., 2003; El-Khamary et al., 2016) Secondly, in contrast with bipolar forceps, clip applier didn't need any extra instrument to facilitate grasping and manipulation of mesorchium. Therefore, it minimizes the number of surgeons and ports, and provides a simple procedural technique as well as reduces operative time. Regarding the possibility of thermal spread (2-6 mm) considered when using bipolar electrocautery as reported by Alkatout et al. (2012); Baumann et al., (1988); Carter (1997); Phipps (1994); Ryder & Hulka (1993), an extra instrument (grasping forceps), two surgeons, and three ports were mandatory to accomplish the procedure. Thirdly, using Multi-Fire clip applier allowed fast firing and efficient placement of multiple clips without exiting the abdomen to reload that efficiently saved time than Single- Fire clip applier and bipolar forceps. This result matches those observed in previous studies (Mayhew & Brown, 2007; Stefanchik et al., 1997). In contrast, technical challenges of bipolar electrocauterization such as a low power setting, carbonizing, and tissue adherence to instrumental jaw with incidental tearing of adjacent blood vessels extended the time needed for the coagulation process (Alkatout et al., 2012; Tucker & Voyles, 1995). Moreover, coagulation process occurred in several stages; blanching, boiling begins, boiling stops, carbonization, and charring (Carter, 1997). Additionally, smoke generation from the coagulated tissues obscure vision, and require the frequent opening of ports to evacuate the smoke. It can lead to loss of pneumoperitoneum, and exposure of the region of interest (Alsafy et al., 2013; Hanrath & Rodgerson, 2002; Mayhew & Brown, 2007). These technical challenges of bipolar forceps were considered the rate-limiting step of the surgical procedure. The safety of the hemostatic technique used to occlude the mesorchium during laparoscopic castration is of top importance if this technique is to be recommended for routine sterilization of male horses. Our results proposed that both techniques were safe for use as none of the cases had sever hemorrhage or needed conversion to an open procedure. Where electrocautery was used, two cases had moderate hemorrhage when the testicular blood vessels were transected without proper coagulation. Although the hemorrhage was not severe and not life-threatening, it obscured the surgical field and resulted in prolongation of surgical time. Application of two to three times of coagulation was mandatory for controlling the hemorrhage efficiently. In contrast, no intraoperative complications were detected with clipping technique. These results are likely to be related to the conventional bipolar electrosurgical forceps is limited for coagulation of vessels of 3 mm in diameter or less (Spivak et al., 1998), and the medium/ large clips can be used efficiently for 3- to 7-mm vessels (Kennedy et al., 1998). These results are consistent with data confirmed that the testicular blood vessels in the normal equine testicle are estimated ultrasonographical 1.9 – 5.4 mm diameter and are, therefore, potentially larger in cases of pathological testicles (Pozor & Kolonko, 2000).

5. CONCLUSION

The present study could conclude that as far as the hemostasis of the mesorchium is concerned, clipping endo-hemostatic technique has comparable results to the bipolar electrocautery method. The clipping technique especially Multi-Fire can be used as a safer and more technical feasible alternative to bipolar electrocautery in occlusion of mesorchium, especially in developing countries where Ultrasonic shears, Harmonic Scalpel, and stapling instruments trigger concerns of cost and affordability.

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