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Do different characteristics of two emasculators make a difference in equine castration?

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Abstract

Background: The Serra and Reimer emasculators are frequently used in equine orchiectomy. They differ in jaw profile and the mechanism by which they achieve haemostasis.

Objectives: To investigate whether the haemostatic capacities of the Reimer and Serra emasculators in open and closed castration differ, to compare the haemostatic capacities of each emasculator in both open and closed castration, and to assess whether the tensile strength of the parietal tunic in closed castration differs according to whether a Reimer or Serra emasculator is used.

Study design: Ex vivo randomised study.

Methods: Eighty equine cadaver testes were randomly assigned to two groups for, respectively, open and closed castration. Each group was divided into two subgroups for castration with a Serra or Reimer castrator, respectively. Testicular artery leaking pressure was measured by dye injection. In closed castration, the tensile strength of the parietal tunic was measured with a tensiometer.

Results: In open castration, the Reimer emasculator resisted significantly higher pressure (median: 706.1 mmHg; interquartile range [IQR]: 597.6-735.5 mmHg) than the Serra emasculator (median: 349.4 mmHg; IQR: 261.1-468.9 mmHg) ($P<0.001$), whereas no difference was found in closed castration (Serra emasculator, median: 382.5 mmHg [IQR: 294.2-568.2 mmHg]; Reimer emasculator, median: 419.2 mmHg [IQR: 294.2-616.0 mmHg]). The Reimer emasculator resisted significantly higher pressure in the open (median: 706.1 mmHg; IQR: 597.6-735.5 mmHg) compared with the closed (median: 419.2 mmHg; IQR: 294.2-616.0 mmHg) technique ($P = 0.03$). Parietal tunic tensile strength did not differ significantly by emasculator (mean ± s.d.: Serra, 12.65 ± 7.35; Reimer, 17.55 ± 11.76).

Main limitations: Limitations are inherent to the ex vivo study design. Post-surgery implications were investigated only in the short term and no account was taken of tissue inflammation and oedema, which may influence the integrity of the tissue.

Conclusions: These results suggest it may be preferable to use a Reimer emasculator in open castration. In this ex vivo model of closed castration, no differences between the emasculators were observed.

Keywords: emasculator; haemostasis; horse; orchiectomy; strength.

Introduction

Orchiectomy is one of the surgical procedures most commonly performed in equine animals. In both the open and closed techniques, an emasculator is used to achieve haemostasis and to simultaneously excise the testis **1**-**3**. Among the tools available, the Serra and Reimer emasculators are the most frequently used **3**-**5**. The two devices differ in jaw profile and therefore in the mechanism by which they achieve haemostasis, and also in the method of testis resection. With the Serra emasculator, haemostasis is achieved by compression, stretching and tearing of tissues, and the spermatic cord is simultaneously crushed and transected by a single closing movement of the jaws. With the Reimer emasculator, haemostasis results from the compression of tissues, and resection is performed by the operator at a later stage using a separate handle on the device.

Only one study has compared the haemostatic properties of the two emasculators in a series of clinical cases **3**. This found that the incidence of haemorrhage is higher when the Reimer rather than the Serra emasculator is used and also when a semi-closed technique is applied **3**. However, comparisons of the performances of emasculators in different surgical techniques are lacking.

The objectives of this study were: 1) to investigate whether the haemostatic capacities provided by the Reimer and Serra emasculators, respectively, differ in both open and closed castration; 2) to compare the haemostatic capacities of each emasculator in open and closed castration, respectively; and 3) to assess whether the tensile strength of the parietal tunic in closed castration differs according to the use of a Reimer or Serra emasculator.

Materials and methods

Testes and whole spermatic cords with the parietal tunic and cremaster muscle were acquired from 40 horses (mean age: 22 months [range: 18–24 months]; mean weight: 450 kg [range: 420–480 kg]). The specimens were stored in 0.9% saline solution and all tests were performed within 4 h of death. The resulting 80 testes were randomly assigned**1** to two groups (open castration and closed castration; 40 samples each). The two groups were further divided into two subgroups of 20 testes each according to the type of emasculator to be applied (Serra**2** or Reimer**2**). All orchiectomies were performed as previously described **1** and by the same surgeon.

The experimental model has been described previously **6**. Lines were marked on the spermatic cord (closed technique) or the vascular bundle (open technique), 3 cm proximal to the epididymis along the proposed site of emasculator application. The testicle was hung from the spermatic cord or vascular bundle in front of graph paper and the diameters of the spermatic cord (closed technique) or vascular bundle (open technique), testicular artery at the proximal aspect of the cord (i.e. approximately 9 cm from the epididymis **6**) and major and minor axes of each testis were measured from digital photographs using Image J.**3**

In the closed castration group, the testis, encapsulated by the parietal tunic, was stripped off the remaining part of the tunica dartos and spermatic fascia. The cremaster muscle was emasculated separately before proceeding with the tunica vaginalis and spermatic cord **1**-**3**, **6**. The emasculator was left in place for 2 min **1**. In the open castration group, an incision was made in the distal part of the parietal tunic to prolapse the testis, the ligament of the tail of the epididymis was severed and the emasculator application site line was marked. Next, the testis, epididymis and distal part of the spermatic cord were excised using the emasculator. The emasculator was left in place for 2 min **1**.

The detached part of each testis was examined to confirm the presence of the complete epididymis and testis. The remaining segment of the spermatic cord or testicular artery was subjected to further testing **6**. An i.v. 22-G catheter**4** was slid partially (5 mm) along its inner trocar to cover the sharp tip. The testicular artery was cannulated about 5 mm proximal to the emasculation site. The artery was proximally sealed using mosquito forceps with two pieces of latex tube around the jaws of the forceps. The catheter was connected to a 50-mL syringe and to an analogue manometer (mmHg) with the aid of three-way inlet tubing to form a closed system (Fig **1**) **6**-**9**. A solution of 0.9% saline solution and methylene blue was slowly infused and pressure was measured until leakage from the distal stump occurred through the site of emasculator application, at which point the value obtained was identified as the maximum leaking pressure **6**-**9**. The end scale of the manometer was set by the manufacturer at 735.5 mmHg. If the specimen did not leak at the end scale pressure, a value of

In the closed castration group, a tension test was performed on both the internal spermatic fascia and the spermatic cord in order to assess parietal tunic tensile strength **6**. Mosquito forceps were attached to the parietal tunic proximal to the emasculation site and to the spermatic cord. The latter was then connected to a digital dynamometer (HCB200K100**5**) and tension applied incrementally until the mechanical failure of the parietal tunic. The maximum value identified the maximum parietal tunic tensile strength **6**, **8**.

Data analysis

Power and sample size were calculated based on leaking pressures using a freely available online sample size calculator**6** with an alpha level of 0.05 and 80% power according to data in a previous similar manuscript **6**. This indicated that 20 specimens per subgroup were required. The distribution of continuous variables was assessed with the Shapiro–Wilk test. Normally distributed data were analysed using parametric tests and reported as the mean ± s.d. Non-normally distributed data were analysed using nonparametric tests and reported as the median (interquartile range [IQR]). Values for the major and minor axes of the testis (cm), testicular artery diameter (mm) and leaking pressure (mmHg) were compared between all subgroups using the Kruskal–Wallis test. Spermatic cord and vascular bundle diameters (mm) were compared between the open and closed castration groups and between the Serra and Reimer subgroups for each

method using a Mann–Whitney test. Parietal tunic tensile strength (N) was compared between the Serra and Reimer subgroups in the closed castration group with a Welch corrected unpaired *t* test. Analyses were carried out using GraphPad Prism 6.0.**7** The level of significance was set at a P≤0.05.

Results

Descriptive statistics are summarised in Table **1**. The spermatic cord diameter in the closed castration group was significantly larger than the vascular bundle diameter in the open castration group (29.3 ± 2.5 mm and 23.1 ± 6.1 mm, respectively; P<0.001). There were no statistically significant differences in the lengths of the testicular major (P = 0.6) and minor (P = 0.45) axes, testicular artery diameter (P = 0.7), spermatic cord diameter (P = 0.7) or vascular bundle diameter (P = 0.3) between the Serra and Reimer subgroups in both the open and closed castration groups.

In the open castration group, leaking pressure was significantly higher in the Reimer subgroup than in the Serra subgroup (P<0.001). In the closed castration group, there was no difference in leaking pressure between the Serra and Reimer subgroups (P>0.9). With the Serra emasculator, there was no significant difference in leaking pressure between the open and closed castration groups (P>0.9). With the Reimer emasculator, leaking pressure was significantly higher in the open castration group than in the closed castration group (P = 0.03). There was no difference in parietal tunic tensile strength (P = 0.1) between the Serra and Reimer subgroups.

Discussion

In the open castration technique, the Reimer emasculator obtained significantly higher leaking pressure than the Serra emasculator, but both instruments produced leaking pressure values higher than physiological values. By contrast, in the closed castration technique, as shown previously **6**, **10**, the Serra emasculator produced leaking pressures quite close to physiological conditions; this may be related to the occurrence of post-operative haemorrhage when this type of instrument is used in the closed technique **6**.

Measurements of the testis and testicular artery indicate that all subgroups were homogeneous and that the only factor that might affect the leaking pressure obtained by the emasculator was the presence or absence of the parietal tunic. Resistance to pressure was independent of surgical technique when the Serra emasculator was used, but was significantly higher in open than in closed castration when the Reimer emasculator was used. Overall, leaking pressure values were higher and further from physiological values in the open technique than in the closed technique. There would appear to be a relationship between leaking pressure and the amount of tissue crushed by the emasculator.

Leaking pressure values were always far from physiological values when the Reimer emasculator was used, but in some cases were close to physiological arterial pressures when the Serra emasculator was used. The difference may be related to the specific mode of operation of each

device. The Reimer emasculator crushes the tissue before the surgeon removes the testis using a blade operated by a separate handle **1**. The Serra emasculator cuts and crushes at the same time and thus may cut without adequately crushing the tissue, which is crucial to haemostasis (Fig **2**). In closed castration, the larger amount of tissue may limit the tissue-crushing capacity of both emasculators. The possibility of increasing the haemostatic capacity of the emasculator by reducing the area of tissue held between the jaws has been proposed **5**.

In closed castration, there was no difference between the two emasculators in parietal tunic tensile strength values. The values obtained with the Reimer emasculator in the current study are not consistent with a reported lower incidence of post-castration haemorrhage with the Serra emasculator **4**. However, the choice of instrument may ultimately depend on the procedure used. A surgeon using a Serra emasculator for closed castration should consider applying a ligature to improve the haemostatic capacity of the device **6**. In both open and closed castration, the Reimer emasculator alone is effective in achieving haemostasis and ligatures are used at the surgeon's discretion. However, ligatures do increase the risk for infection **6**.

Most of the limitations of the present study relate to its ex vivo and short-term design. The study did not take into account tissue inflammation and oedema, which may influence the integrity of the tissue. In addition, the strength of the parietal tunic may be altered in vivo by the forces exerted by intestines at the time of herniation, which may differ from the conditions of these ex vivo experimental models. The upper measurement limit of the manometer used was 735.5 mmHg. Although this value is extremely high from a clinical perspective, this maximal value may have influenced the statistical analysis.

In conclusion, in open castration the Reimer emasculator performed better than the Serra emasculator. In closed castration, there was no statistically significant difference in leaking pressure between the emasculators, but, in some cases, use of the Serra emasculator may lead to a leaking resistance that is very close to the physiological arterial pressure in horses. Further studies are required to better quantify the factors associated with post-castration haemorrhage in the clinical setting.

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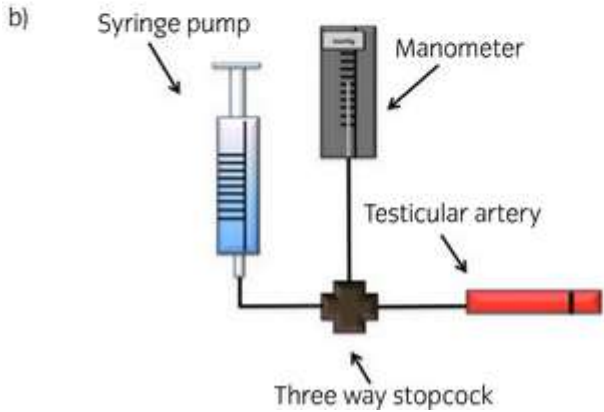
Figure

Figure 1 a) Cannulation of the testicular artery with the closed system attached. b) schematic representation of the closed system.

Figure 2 The spermatic cord crushed and cut with a) the Serra emasculator and b) the Reimer emasculator.

Table:

Table 1. Major and minor testicular axes dimensions, spermatic cord, vascular bundle and testicular artery diameters, and leaking pressure and tensile strength in the castration subgroups (n = 20 per subgroup)

Castration subgroup	Major axis of testis, cm, median (IQR)	Minor axis of testis, cm, mean ± s.d.	Spermatic cord diameter, mm, mean ± s.d.	Vascular bundle diameter, mm, mean ± s.d.	Testicular artery diameter, mm, median (IQR)	Leaking pressure, mmHg, median (IQR)	Tensile strength, N, mean ± s.d.
Open: Serra	10 (8.25–11.00)	5.4 ± 1.35	–	21.7 ± 4.78	3.0 (2.00–5.00)	349.4 (261.1–468.9)[a]	–

Castration subgroup	Major axis of testis, cm, median (IQR)	Minor axis of testis, cm, mean ± s.d.	Spermatic cord diameter, mm, mean ± s.d.	Vascular bundle diameter, mm, mean ± s.d.	Testicular artery diameter, mm, median (IQR)	Leaking pressure, mmHg, median (IQR)	Tensile strength, N, mean ± s.d.
Open: Reimer	10 (8.25–10.75)	5.7 ± 1.74	–	24.4 ± 7.08	3.0 (2.50–5.00)	706.1 (597.6–735.5)[a,b]	–
Closed: Serra	10 (9.00–11.00)	5.9 ± 1.70	28.7 ± 1.61	–	3.0 (2.00–4.75)	382.5 (294.2–568.2)	12.65 ± 7.35
Closed: Reimer	9 (8.00–10.75)	5.1 ± 1.53	29.7 ± 3.24	–	3.5 (2.63–5.00)	419.2 (294.2–616.0)[b]	17.55 ± 11.76

- Significant differences: [a]P = 0.0005; [b]P = 0.025.
- IQR, interquartile range.