



## Male reproductive tract disorders in equids: 87 cases (2014-2022)<sup>1</sup>

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Male reproductive tract disorders (MRTDs) are common in equids and may represent a significant proportion of the caseload of equine practitioners. Herein, we determined the frequency, clinico-pathological findings, and therapeutics of MRTDs in equids from a 9-year survey of the clinical records of a Veterinary Teaching Hospital in Midwestern Brazil. During this period, 87 affected equids presented 100 MRTDs distributed in 17 different diagnoses. Forty-three (49.4%) equids presented MRTDs affecting the glans penis or preputial skin fold. Testicles, scrotum, and spermatic cords disorders were diagnosed in 32 (36.8%) horses. Of the remaining 12 (13.8%) horses, six presented two different MRTDs on two distinct anatomical areas, and five animals exhibited the same disease, affecting two different anatomical locations. Only one horse presented three distinct MRTDs on two anatomical regions. Habronemiasis was the most frequent MRTD detected in 26% of the diagnoses, followed by miscellaneous wounds (14%), cryptorchidism (13%), inguinal hernia (13%), funiculitis (9%), paraphimosis (6%), squamous cell carcinoma (5%), urethrolithiasis (3%), preputial abscesses, and orchitis (2% each). Phimosis, ulcerative posthitis, epididymitis, hydrocele, papillomatosis, teratoma, and testicular torsion accounted for 1% each. Sixty-three (72.5%) equids received hospital discharge, 18 (20.6%) were humanely euthanized, and six (6.9%) died. This study detected the most relevant MRTDs that affected over 7.5% in a survey of 1,154 equids referred for hospital care. Our finding highlights that MRTDs may be debilitating and life-threatening conditions, and they can potentially impact the reproduction of equids in the region. This knowledge may support equine practitioners in elaborating proper sanitary and management protocols to prevent and reduce the incidence of most MRTDs recorded, improving equid production and welfare.

**INDEX TERMS:** Cryptorchidism, geldings, habronemiasis, penile and preputial wounds, stallions, reproductive tract disorder, equids.

### **RESUMO.- [Distúrbios do trato reprodutivo masculino em equídeos: 87 casos (2014-2022).]** Distúrbios do trato

reprodutivo masculino (DTRMs) são comuns em equídeos e podem representar uma proporção significativa da casuística de hipiatras. Determinamos a frequência, os achados clínico-patológicos e a terapêutica de DTRMs em equídeos a partir de um levantamento de nove anos dos registros clínicos em um Hospital Veterinário no Centro-Oeste do Brasil. Nesse período, 87 equinos afetados apresentaram 100 DTRMs distribuídos em 17 diagnósticos diferentes. Quarenta e três (49,4%) equídeos apresentaram DTRM afetando a glândula peniana ou pregas de pele preputial. Distúrbios dos testículos, escroto e cordão espermático foram diagnosticados em 32 (36,8%)

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equinos. Dos 12 (13,8%) equinos restantes, seis apresentaram dois DTRMs diferentes em duas áreas anatômicas distintas, e cinco animais exibiram a mesma doença em duas localizações anatômicas diferentes. Apenas um cavalo apresentou três DTRMs distintas em duas regiões anatômicas. A habronemíase foi a DTRM mais frequente detectada em 26% dos diagnósticos, seguida por feridas diversas (14%), criptorquidismo (13%), hérnia inguinal (13%), funiculite (9%), parafimose (6%), carcinoma de células escamosas (5%), uretrolitíase (3%), abscessos prepuciais e orquite (2% cada). Fimose, postite ulcerativa, epididimite, hidrocele, papilomatose, teratoma e torção testicular representaram 1% cada. Sessenta e três (72,5%) equídeos receberam alta hospitalar, 18 (20,6%) foram sacrificados humanitariamente e seis (6,9%) morreram. Este estudo detectou as DTRMs mais relevantes que afetaram 7,5% dos pacientes em um levantamento de 1.154 equídeos encaminhados para atendimento hospitalar. Este achado destaca que as DTRMs podem ser condições debilitantes e com risco de morte, e podem impactar potencialmente a reprodução de equídeos na região. Este conhecimento pode ajudar os hipiatras a elaborar protocolos sanitários e de manejo adequados para prevenir e reduzir a incidência da maioria das DTRMs registradas, melhorando a produção e o bem-estar dos equídeos.

**TERMOS DE INDEXAÇÃO:** Cavalos castrados, criptorquidismo, feridas prepuciais e penianas, habronemose, garanhões, trato reprodutivo, equídeos.

## INTRODUCTION

Male reproductive tract disorders (MRTDs) are common in equids and may represent a significant proportion of the caseload of equine practitioners. Considering that horse herds include over 5.7 million animals in Brazil (IBGE 2021), affections of the male reproductive tract can cause a reduction in fertility and even disuse in the reproduction of stallions with high genetic and economic potential. Additionally, MRTDs may result in a significant economic impact on stud farms as well as on the entire horse industry (Snider 2015).

The equine penis and prepuce affections range from proliferative/neoplastic lesions to infectious and inflammatory causes. Several pathological conditions in the testicle, epididymis, and spermatic cords have been reported in intact equine males. However, there are a few significant diagnostic issues in the scrotum and *tunica vaginalis*. Even though the exceeding majority of male horses are castrated during the young adult years, neoplasms affecting the male reproductive tract of geldings have been frequently observed (Foster & Laads 2015, Snider 2015). In this context, a proper clinical and pathological evaluation of genital lesions in male horses is essential for the correct diagnosis and proper treatment (Veado et al. 2021).

In this sense, retrospective studies may contribute to determining the frequency of main diseases of the male equine reproductive tract, their epidemiological aspects, and economic losses to equestrian activity. The present study performed a 9-year survey of MRTDs in the records of equids referred for clinical evaluation and care at a Veterinary Teaching Hospital in Midwestern Brazil. The frequency, clinico-pathological findings, and therapeutics of MRTDs in equids were determined.

## MATERIALS AND METHODS

**Animal Ethics.** The equids detailed in this study were referred as patients to the Large Animal Veterinary Teaching Hospital, "Universidade de Brasília" (UnB). The cases management was not altered by the study and no ethical approval was obtained. The owners signed a consent form to permit hospitalization and treatment. Additional consent was obtained for anonymized necropsy and *post mortem* samples for research purposes. The authors confirm that the study has followed the guidelines of the 1964 Declaration of Helsinki and its later amendments.

A 9-year survey (from January 2014 to December 2022) was conducted in the archives of clinical records of equids referred to the Large Animal Veterinary Teaching Hospital, UnB, Brasília, Distrito Federal, Midwestern Brazil. All selected cases included a conclusive diagnosis of MRTDs based on a combination of epidemiological, clinical, laboratory, and/or pathological evaluation. All testicular affections in this study were confirmed after orchiectomy (e.g., cryptorchidism, testicular tumors, and inguinal hernias), and elective orchiectomies were excluded.

Epidemiological data included breed, age, clinical evolution, and anatomical distribution of lesions. Equids were grouped by age: <1 year, one to five years, six to 14 years, and over 15 years. All animals were clinically evaluated, and when penile and preputial skin fold exposition was needed, a light tranquilization was performed (acepromazine: 0.1mg.kg<sup>-1</sup>, intravenously) (Veado et al. 2021). MRTDs were identified according to the affected anatomical regions in the prepuce, glans penis, testis, scrotum, and spermatic cords. These affections were accounted individually for equids with MRTDs in multiple anatomical locations. Traumatic injuries, including lacerating, cutting, incised, and perforated wounds containing or not exuberant granulation tissue (EGT) and/or myiasis, were classified as miscellaneous wounds (MW).

All diagnoses were determined in the gross inspection of affected areas and by histological evaluation of tissue samples (biopsy or surgical excision), and dead animals (spontaneous death or euthanized) were submitted for necropsy. Tissues were fixed in 10% buffered formalin, routinely processed, paraffin-embedded, sectioned at 5µm, and stained with hematoxylin and eosin (HE) for evaluation in an optical microscope. When required, complementary ancillary tests were performed to confirm the diagnoses (ultrasonography and microbiological tests). The diagnosis of cutaneous habronemiasis in our study was made through characteristic histological features such as exuberant fibrovascular tissue, marked infiltration of eosinophils around multifocal necrotic centers, cross-sections of larvae with prominent cuticular ridges morphologically compatible with *Habronema* sp. As previously reported, immunohistochemical assays were performed in cases of epithelial neoplasms in the genital tract (Veado et al. 2021).

## RESULTS

From January 2014 to December 2022, 2,943 farm animals were referred to the Large Animal Veterinary Teaching Hospital, UnB, Midwestern Brazil. During this period, 65% (1,913/2,943) of the attendances were equids. Males represented 1,154 of all equids (60.3%; 1,154/1,913), including 1,129 (97.8%) horses, 20 (1.7%) mules, and five (0.5%) donkeys. Eighty-seven equids (7.5%; 87/1,154), which included 84 (96.5%) horses, two (2.3%) donkeys, and one (1.2%) mule, were attended due to complaints related to MRTDs.

Of the 87 affected equids, 100 MRTDs were detected and distributed in 17 different diagnoses (Table 1). Twenty-six equids were between 1-5 years old (29.9%), 29 (33.3%) between 6-14 years, 10 (11.5%) over 15 years, and six (6.9%) were foals (<1 year). Age information was unavailable in the records of 16 (18.4%) equids. Most horses were crossbreeds (n=32; 36.7%), followed by Mangalarga Marchador (n=23; 26.4%), Quarter Horse (n=11; 12.5%), Campolina (n=4; 4.6%), Crioulo (n=4; 4.6%), Arabian (n=3; 3.4%), and Lusitano (n=2; 2.3%) breeds. Brasileiro de Hipismo, Mangalarga Paulista, Thoroughbred, Pantaneiro, and pony breeds accounted for one (1.2%) horse each. Two donkeys (2.3%) of the Pêga breed and one crossbred mule (1.2%) also showed MRTDs.

Epidemiological data are presented in Table 2-4. Forty-three (40 horses, two donkeys, and one mule) equids presented MRTDs affecting the glans penis or preputial skin fold (Table 2). Testicles, scrotum, and spermatic cords disorders were diagnosed in 32 horses (Table 3). A total of 75 (86.2%; 75/87) equids presented one MRTD affecting just a single anatomical location. Of the remaining 12 (13.8%; 12/87) horses, there were two different MRTDs on two distinct anatomical areas in six horses (50%; 6/12), and five animals (41.7%; 5/12) exhibited the same disease affecting two different anatomical locations (Table 4). Only one horse (8.3%; 1/12) presented three distinct MRTDs on two anatomical regions (Table 4, Case 6).

Gross and pathological findings observed in affected equids were hallmarks for diagnosing all MRTDs in this study. Habronemiasis (Fig.1-5) was the most frequent MRTD followed by MW (14%; 14/100) (Fig.6-7) detected in 26% (26/100) of the diagnoses, followed by MW (14%; 14/100), cryptorchidism (13%; 13/100), inguinal hernia (13%; 13/100), funiculitis (9%; 9/100) (Fig.8-9), paraphimosis (6%; 6/100), squamous cell carcinoma (SCC) (5%; 5/100) (Fig.10-11), urethrolithiasis (3%; 3/100), preputial abscesses (Fig.12) and orchitis (2% each; 2/100). Phimosis, ulcerative

posthitis, epididymitis, hydrocele, papillomatosis (Fig.13), teratoma, and testicular torsion accounted for 1% (1/100) each (Table 1). Cryptorchidism was observed in seven (53.9%; 7/13) horses with unilateral inguinal retention (four right and three left-sided), four (30.8%; 4/13) cases of abdominal unilateral retention (three right and one left-sided), and two (15.3%; 2/13) horses with bilateral abdominal retention. One of them, an Arabian stallion, presented teratoma (Fig.14) on both retained testicles (Table 4, Case 7).

Of the 87 equids with MRTDs, 63 (72.5%) received hospital discharge, 18 (20.6%) were humanely euthanized, and six (6.9%) died. Euthanasia was performed due to welfare issues and poor prognosis in cases of inguinal hernia (33.3%; 6/18), paraphimosis (22.2%; 4/18), MW (11.1%; 2/18), SCC (11.1%; 2/18), habronemiasis (5.575%; 1/18), botryomycotic funiculitis (5.575%; 1/18), orchitis/epididymitis (5.575%; 1/18) and phimosis (5.575%; 1/18). Spontaneous death occurred in cases of MW (33.3%; 2/6), SCC, preputial abscesses, cryptorchidism, and paraphimosis (16.675% each; 1/6).

## DISCUSSION AND CONCLUSION

Reproducing outstanding or high-genetic animals is among the most relevant businesses of equids husbandry in the horse industry. MRTDs may directly impact the reproduction performance of stallions, promoting significant economic losses (Snider 2015). In the present study, habronemiasis represented the major MRTD in equids referred for hospital care, affecting the glans penis and/or preputial skin fold. Cutaneous habronemiasis (CH) or "summer sores" result from erratic migration of *Habronema* sp. larvae deposited on abraded skin, wounds, and mucocutaneous junctions of equids. Tumor-like lesions characterized by a severe inflammatory reaction, fibrosis, and granulation tissue are typical hallmarks of CH in equids (Barlaam et al. 2020, Veado et al. 2021), as

**Table 1. Distribution by age of the 100 diseases of the male reproductive system affecting 87 equids from January 2014 to December 2022**

Disease	Age				NAD	Total
	<1-year	1-5 years	6-14 years	>15-years		
Habronemiasis	-	10	7	3	6	26
Miscellaneous wounds	1	2	6	1	4	14
Cryptorchidism	-	7	3	-	3	13
Inguinal hernia	5	4	3	-	1	13
Funiculitis	-	3	4	-	2	9
Paraphimosis	-	-	1	4	1	6
Squamous cell carcinoma	-	-	2	2	1	5
Urethrolithiasis	-	1	2	-	-	3
Preputial abscesses	-	-	1	-	1	2
Orchitis	1	-	1	-	-	2
Phimosis	-	-	-	1	-	1
Ulcerative posthitis	-	-	1	-	-	1
Epididymitis	1	-	-	-	-	1
Hydrocele	-	-	1	-	-	1
Papillomatosis	-	-	-	1	-	1
Teratoma	-	1	-	-	-	1
Testicular torsion	-	1	-	-	-	1
						100

NAD = No available data.

observed in this study. The inner side of the legs, head, chest, and fetlocks are the most commonly affected skin areas by CH (Pessoa et al. 2014, Bianchi et al. 2016, Barlaam et al. 2020).

In contrast to our findings in equids from the Midwestern Region, the urogenital system had a low incidence (0.44%) of CH in horses in Southern Brazil (Bianchi et al. 2016). It may be related to differences in the region's abundance of gastric parasites and flies, horse care management, environment,

and climate. In our experience, treatment may be challenging since most cases are refractory to isolated medical therapy, and surgical resection and/or debulking are advisable. Prophylaxis to decrease the incidence and prevent the recurrence of CH includes regular deworming of the equids and cleaning of the stables and paddocks with proper removal and disposal of manure as part of an integrated fly control plan. Using licensed repellents, fly masks, and blankets are

**Table 2. Epidemiological data from 43 equids (40 horses, two donkeys and one mule) with disorders of the glans penis or prepuce from January 2014 to December 2022**

Case	Specie	Breed	Age	Clinical evolution (days)	Diagnose	Lesion location	Treatment	Outcome
1	Equine	MM	14-y	NAD	MW	Glans penis	Clinical	Euthanasia
2	Equine	Crossbred	5-y	6	MW	Glans penis	Clinical	Euthanasia
3	Equine	Crossbred	NAD	13	MW	Prepuce	Clinical	Death
4	Equine	MM	5-y	183	Habronemiasis	Glans penis	Surgical	Discharged
5	Equine	Crossbred	NAD	92	Habronemiasis	Prepuce	Clinical	Discharged
6	Equine	Crossbred	8-y	5	MW	Prepuce	Clinical	Discharged
7	Equine	Arabian	5-y	150	Habronemiasis	Prepuce	Surgical	Discharged
8	Equine	Crossbred	16-y	10	Paraphimosis	Glans penis	Surgical	Death
9	Equine	Crossbred	NAD	92	Abscesses	Prepuce	Surgical	Discharged
10	Equine	Crossbred	17-y	11	Paraphimosis	Glans penis	Clinical	Euthanasia
11	Equine	Crossbred	NAD	4	Habronemiasis	Prepuce	Clinical	Euthanasia
12	Equine	MM	20-y	122	MW	Prepuce	Surgical	Discharged
13	Equine	Crossbred	8-y	1	Abscesses	Prepuce	Clinical	Death
14	Equine	Crioulo	3-y	35	Habronemiasis	Prepuce	Surgical	Discharged
15	Equine	Crossbred	6-y	NAD	Habronemiasis	Prepuce	Clinical	Discharged
16	Equine	Crossbred	4-y	60	Habronemiasis	Prepuce	Clinical	Discharged
17	Equine	QH	30-y	2	SCC	Prepuce	-	Euthanasia
18	Equine	MM	5-y	122	Habronemiasis	Glans penis	Clinical	Discharged
19	Equine	MM	11-y	21	SCC	Glans penis	Surgical	Death
20	Equine	Crioulo	8-y	45	Habronemiasis	Glans penis	Surgical	Discharged
21	Equine	Crossbred	9-y	31	Habronemiasis	Prepuce	Clinical	Discharged
22	Equine	Crossbred	10-y	NAD	Uretrolithiasis	Glans penis	Surgical	Discharged
23	Equine	MM	8-y	15	Habronemiasis	Prepuce	Clinical	Discharged
24	Equine	Pantaneiro	3-y	24	MW	Prepuce	Clinical	Discharged
25	Equine	QH	4-y	45	Habronemiasis	Glans penis	Surgical	Discharged
26	Equine	MP	8-y	60	Habronemiasis	Glans penis	Clinical	Discharged
27	Equine	QH	12-y	90	Habronemiasis	Glans penis	Clinical	Discharged
28	Equine	QH	4-y	153	Habronemiasis	Prepuce	Surgical	Discharged
29	Equine	Crossbred	4-y	NAD	Uretrolithiasis	Glans penis	Surgical	Discharged
30	Equine	QH	NAD	9	MW	Prepuce	Clinical	Discharged
31	Equine	Arabian	23-y	48	Habronemiasis	Prepuce	Clinical	Discharged
32	Equine	Crossbred	22-y	15	SCC	Glans penis	Surgical	Discharged
33	Equine	Crossbred	20-y	122	Habronemiasis	Prepuce	Clinical	Discharged
34	Equine	QH	5-y	91	Habronemiasis	Prepuce	Surgical	Discharged
35	Equine	Crossbred	12-y	1	SCC	Prepuce	-	Euthanasia
36	Equine	Crossbred	10-y	2	Paraphimosis	Glans penis	Surgical	Euthanasia
37	Equine	Lusitano	23-y	35	Paraphimosis	Glans penis	Surgical	Discharged
38	Equine	Crossbred	16-y	91	Paraphimosis	Glans penis	Clinical	Euthanasia
39	Equine	Crossbred	14-y	52	MW	Glans penis	Surgical	Discharged
40	Equine	Crossbred	NAD	5	Paraphimosis	Glans penis	Clinical	Euthanasia
41	Mule	Crossbred	13-y	1	Uretrolithiasis	Glans penis	Surgical	Discharged
42	Asinine	Pêga	18-y	61	Phimosis	Glans penis	Surgical	Euthanasia
43	Asinine	Pêga	12-y	40	MW	Prepuce	Clinical	Discharged

MM = Mangalarga Marchador, QH = Quarter horse, MP = Mangalarga Paulista, MW = miscellaneous wounds, NAD = no available data, SCC = squamous cell carcinoma.

**Table 3. Epidemiological data from 32 horses with disorders of the testicles, scrotum or spermatic cord from January 2014 to December 2022**

Case	Breed	Age	Clinical evolution (days)	Diagnose	Lesion location	Treatment	Outcome
1	MM	4-months	NAD	Inguinal hernia	Scrotum	Surgical	Discharged
2	MM	4-y	NAD	Right abdominal cryptorchid	Testicles	Surgical	Discharged
3	MM	NAD	NAD	Right inguinal cryptorchid	Testicles	Surgical	Discharged
4	MM	1-day	8	Inguinal hernia	Scrotum	Surgical	Discharged
5	MM	5-y	30	Funiculitis	Spermatic cords	Clinical	Discharged
6	Campolina	5-y	15	Bilateral abdominal cryptorchid	Testicles	Surgical	Discharged
7	MM	NAD	2	Funiculitis	Spermatic cords	Clinical	Discharged
8	MM	5-y	18	Left inguinal cryptorchid	Testicles	Surgical	Discharged
9	Crossbred	NAD	NAD	Right inguinal cryptorchid	Testicles	Surgical	Discharged
10	Pony	10-y	13	Funiculitis (botryomycosis)	Spermatic cords	Surgical	Euthanasia
11	Campolina	3-y	15	Left abdominal cryptorchid	Testicles	Surgical	Discharged
12	MM	NAD	7	Left inguinal cryptorchid	Testicles	Surgical	Discharged
13	BH	4-y	14	Right abdominal cryptorchid	Testicles	Surgical	Discharged
14	Campolina	5-y	1	Inguinal hernia	Scrotum	Surgical	Euthanasia
15	Campolina	4-y	10	Right inguinal cryptorchid	Testicles	Surgical	Discharged
16	MM	4-months	12	Inguinal hernia	Scrotum	Surgical	Discharged
17	MM	2-months	12	Inguinal hernia	Scrotum	Surgical	Discharged
18	MM	5-y	12-h	Inguinal hernia	Scrotum	-	Euthanasia
19	Crioulo	NAD	20	Funiculitis	Spermatic cords	Surgical	Discharged
20	MM	6-y	2	Hydrocele	Testicles	Clinical	Discharged
21	QH	9-y	14	Funiculitis	Spermatic cords	Surgical	Discharged
22	Thoroughbred	6-y	22	Funiculitis	Spermatic cords	Surgical	Discharged
23	MM	4-y	8	Funiculitis	Spermatic cords	Surgical	Discharged
24	QH	8-y	NAD	Right inguinal cryptorchid	Testicles	Surgical	Death
25	Crossbred	8-y	NAD	Left inguinal cryptorchid	Testicles	Surgical	Discharged
26	Crossbred	9-y	5	Funiculitis	Spermatic cords	Surgical	Discharged
27	Lusitano	NAD	NAD	Inguinal hernia	Scrotum	Surgical	Euthanasia
28	Crioulo	7-y	4-h	Inguinal hernia	Scrotum	Surgical	Discharged
29	QH	5-y	6-h	Inguinal hernia	Scrotum	Surgical	Discharged
30	MM	9-y	30-h	Inguinal hernia	Scrotum	Surgical	Euthanasia
31	QH	7-y	36-h	Inguinal hernia	Scrotum	Surgical	Euthanasia
32	MM	6-y	5	Funiculitis	Spermatic cords	Surgical	Discharged

MM = Mangalarga Marchador, BH = Brasileiro de Hipismo, QH = Quarter horse, NAD = no available data.

**Table 4. Epidemiological data from 12 horses with concomitant disorders of the male reproductive tract from January 2014 to December 2022**

Case	Breed	Age	Clinical evolution (days)	Diagnoses and lesion location	Treatment	Outcome
1	MM	13-y	NAD	MW (glans penis and prepuce)	Clinical	Discharged
2	Crossbred	NAD	60	Habronemiasis (glans penis and prepuce)	Clinical	Discharged
3	Crossbred	12-y	150	Orchitis/ulcerative posthitis (testicles and prepuce)	Surgical	Discharged
4	Crossbred	NAD	24	Habronemiasis (glans penis and prepuce)	Surgical	Discharged
5	Crossbred	8-months	90	MW (prepuce) and inguinal hernia (scrotum)	Surgical	Discharged
6	Crossbred	18-y	91	SCC and papillomatosis (glans penis); habronemiasis (prepuce)	Surgical	Discharged
7	Arabian	4-y	20	Bilateral abdominal cryptorchid and teratoma (testicles)	Surgical	Discharged
8	QH	5-y	8-h	Testicular torsion(testicles) and inguinal hernia (scrotum)	Surgical	Euthanasia
9	Crossbred	NAD	1	MW (glans penis and prepuce)	Clinical	Death
10	MM	4-y	60	Habronemiasis (glans penis and prepuce)	Clinical	Discharged
11	MM	6-months	NAD	Epididymitis and orchitis (testicles)	Clinical	Euthanasia
12	Crossbred	7-y	120	Habronemiasis (prepuce) and right abdominal cryptorchid	Surgical	Discharged

MM = Mangalarga Marchador, QH = Quarter horse, MW = miscellaneous wound, NAD = no available data, SCC = squamous cell carcinoma.

other relevant prophylactic measures to control flies and CH transmission (Barlaam et al. 2020). Diagnosis of tumor-like lesions on the prepuce and penis of equids includes mostly phycomycosis, pythiosis, cutaneous habronemiasis, granulation tissues, SCCs, squamous papillomas, and sarcoid (Veado et al. 2021). Pythiosis is a chronic inflammatory disease caused by the oomycete *Pythium insidiosum* affecting domestic and wild animals and humans. Horses are the most commonly affected among domestic animals. The lesions are located mainly on the distal extremities and the ventral aspect of the thoracoabdominal wall, body parts most often in prolonged contact with contaminated water (Souto et al. 2021). Therefore, histopathological evaluation of genital proliferative lesions in male horses is one of the most reliable ancillary tests to

differentiate ulcerated wound-like lesions on the penis and prepuce, enabling the correct treatment selection (Veado et al. 2021).

MW included trauma-induced injuries to the glans penis and/or preputial skin fold ranging from acute (laceration, perforation, or excoriation) and chronic (infected, with myiasis or EGT) presentations in the affected equids. Penile and preputial wounds have been related to direct injury during copulation, fights with other horses, trauma while attempting to breed mares through fences, or other different types of accidents (Barbosa et al. 2022). When improperly managed, these wounds can develop myiasis or EGT formation, as observed in several cases herein. Additionally, an opportunistic infection of penile and preputial wounds may spread to the

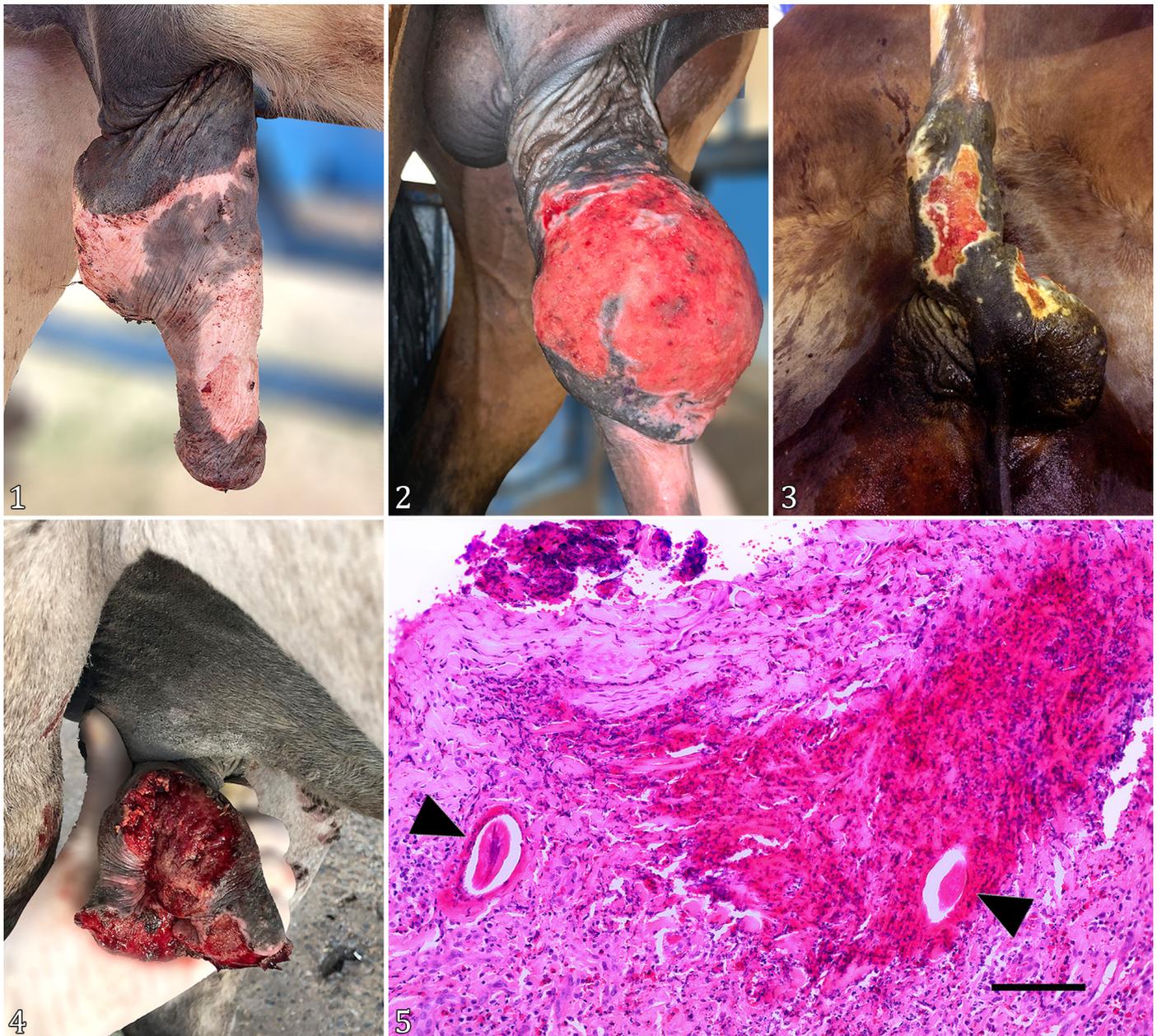


Fig.1-5. Horses, habronemiasis. (1 and 2) Glans penis. Fibrotic enlargement causing paraphimosis. (3 and 4) Prepuce. Multifocal ulcerated wounds on the preputial skin fold. (5) Preputial folds. Ulcerated skin with a focally extensive area of necrosis surrounded by inflammatory infiltrate and intralesional sections of *Habronema* sp. larvae (arrow heads). HE, bar = 50 $\mu$ m.

surrounding tissues due to the loose feature of preputial alveolar tissue, predisposing to other complications, such as preputial abscesses, orchitis and epididymitis (Schumacher & Varner 2007, Foster & Laads 2015). Systemic infections have been observed in some cases of bacterial spread from these infected wounds (Moreira et al. 2018).

Cryptorchid horses tied with inguinal hernias as our study's third most frequent MRTDs. Cryptorchidism is the failure of one or both testis to descend into the scrotum, and is one of the most frequent developmental disorders in horses (Foster & Ladds 2015). As previously reported, unilateral testis retention was more prevalent than bilateral presentation, and right-sided inguinal retention was also higher in frequency than left-sided retention in the evaluated horses (Hayes 1986, Straticò et al. 2020). Abdominal cryptorchidism was more frequent on the right side (n=3) or bilateral (n=2), and just one animal was affected on the left testis in our survey, despite left abdominal retention being more frequent in

horses (Snider 2015, Straticò et al. 2020). As observed in both cases of bilateral cryptorchidism in equids, abdominal retention of the testis has been considered 2.5 times more common than the inguinal form (Straticò et al. 2020). A bilateral testicular teratoma was observed in one horse with abdominal cryptorchidism, but this neoplasm bilaterally is considered a rare feature (Ugolini et al. 2019). Cryptorchidism is a well-known risk factor for development of testicular tumors (Foster & Ladds 2015, Snider 2015), and teratoma is considered the most frequent testicular tumor in young stallions (1 to 5-year-old) (Snider 2015).

Congenital inguinal hernias in this study mainly affected foals ranging from one day to eight months-old (n=5). All animals showed large-sized hernias surgically corrected by inguinal canal closure and had an uneventful post-operative evolution. In the other eight cases of acquired inguinal hernias with a clinical evolution ranging from six to 36 hours, six stallions (75%, 6/8) were euthanized due to extensive intestinal



Fig.6-9. Horses with MRTDs. (6) Exuberant granulation tissue (EGT) on the glans penis. (7) Close view of EGT with marked proliferative aspect after partial phallectomy. (8) Severe subcutaneous edema on the prepuce and inguinal region in a case of funiculitis. (9) Multiple subcutaneous enlargements and a suppurative draining tract on the preputial region in a case of botryomycotic funiculitis.

ischemic lesions and poor prognosis. In one of these animals, a Quarter horse stallion, the intestinal protrusion into the scrotum also promoted a testicular torsion.

Inguinal herniations are usually congenital and often resolve within 3-6 months in foals, but surgery is advisable when there is no spontaneous reduction or clinical treatment

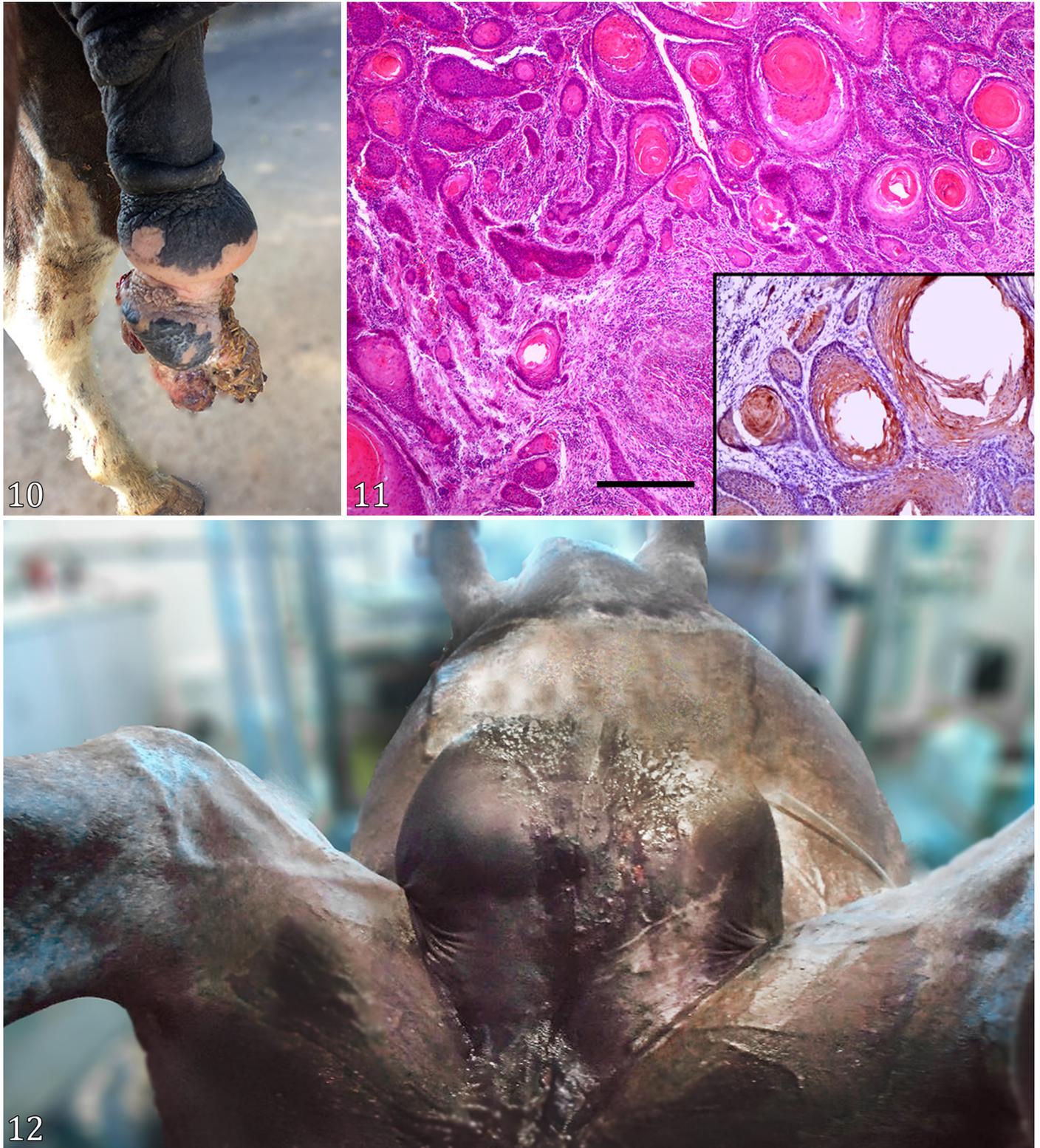


Fig.10-12. Horses with MRTDs. **(10)** Squamous cell carcinoma (SCC) on the glans penis of a gelding presenting severely ulcerated wounds. **(11)** Penis folds. SCC. Numerous keratin pearls and epithelial neoplastic cell cords infiltrating the dermis. HE, bar = 250µm. Inset: neoplastic epithelial cells with strong immunostaining for pan-cytokeratin (Immunoperoxidase, diaminobenzidine) IHC, bar = 250µm. **(12)** Severe and diffuse preputial enlargement due to abscessation.

fails (Foster & Ladds 2015). In contrast, acquired inguinal hernias are more prevalent in stallions and potentially life-threatening due to the risk of intestinal strangulation (Van der Velden 1988, Kovac et al. 2018). Inguinal and scrotal hernias have been used interchangeably in the name of the condition (Kovac et al. 2018) and occur when the intestine protrudes through the vaginal ring into the inguinal canal, reaching the scrotum. Testicular torsions in cases of intestinal protrusion are usually associated with colic-like pain and loss of testicular function and spermatogenesis (Snider 2015).

Regarding the nine cases of funiculitis in this study, seven (77.8%) were surgically and two (22.2%) clinically treated, respectively. Of these animals, only a 10-year-old pony showed pulmonary botryomycosis secondary to septic funiculitis and a fatal outcome (Moreira et al. 2018). Funiculitis in horses usually results from inadequate surgical site preparation, neglected perioperative antimicrobial treatment, an extension of a scrotal infection, or contamination of surgical material (Kilcoyne 2013, Moreira et al. 2018, Duggan et al. 2021). Proper use of antimicrobials may be efficient in the early stages of funiculitis, but occasionally, surgical resection of the infected stump is necessary (Kilcoyne 2013, Duggan et

al. 2021). Funiculitis, also referred to as a scirrhus cord, is characterized by a chronic infection of the spermatic cord stump as a complication of castration. Surgical scrotal incisions in orchietomies attempt to heal with persistent spermatic cord stump infections that eventually fistulate, forming a draining tract (Kilcoyne 2013). In this study, most funiculitis cases were sequelae of castration of equids performed by non-veterinarian practitioners, remaining a common practice in the field that represents a hazard to animal welfare.

Most equids with paraphimosis (83.3%; 5/6) herein were associated with severe debilitation, cachexia, and recumbency and were humanely euthanized. Paraphimosis is considered a multifactorial syndrome related to several predisposing factors (Silva et al. 2017), such as preputial edema (secondary to trauma or systemic diseases), damage to innervation of the penis (which may accompany some neurologic disorders, such as equine herpesvirus infection), severe debilitation, and administration of phenothiazine-derivative tranquilizers (Schumacher & Varner 2007, Silva et al. 2017). As a consequence of paraphimosis, there is venous and lymphatic drainage of the penis and prepuce impairment, which leads to edema of the internal preputial lamina, preputial ring constriction, predisposing penile excoriations, and infections. In addition, penile paralysis may be related to internal pudendal nerve damage due to the weight of the pendulous protruded penis and prepuce. In chronic cases, fibrosis of the internal preputial lamina may promote a loss of prepuce normal telescoping action (Schumacher & Varner 2007).

In the present study, five geldings from 11 to 30 years old showed SCC on the glans penis. Most affected horses developed debilitating conditions, such as cachexia and poor body condition, and were humanely euthanized or died. One gelding was successfully treated with tumor resection and topical 5-fluorouracil treatment (Veado et al. 2021), and another animal was submitted to radical phallectomy and entirely recovered. The urogenital region is considered the third most frequently affected body location by tumors and tumor-like skin lesions in horses (Bianchi et al. 2016). SCC has one of the highest prevalence in the penile and preputial regions of horses among skin neoplasms and may be associated with smegma accumulation and papillomavirus infections (Van den Top et al. 2011, Veado et al. 2021).

Urethrolithiasis was diagnosed in two horses and one mule, causing abdominal discomfort and colic-like symptoms. All equids were treated surgically with a complete recovery. Calculi in horses are most commonly found in the urinary bladder, while urethral, renal, or ureteral calculi are uncommon. Urethral obstruction by large uroliths is rare in horses but is a potentially severe clinical condition variable with the degree of the urinary blockage (Laverty et al. 1992, Campebell et al. 2021). Phimosis, ulcerative posthitis, epididymitis, hydrocele, and papillomatosis accounted for only 1% of each (1/100) of all cases in our hospital attendance routine. Ulcerative posthitis is an uncommon disease in Brazilian horses, and usually, infectious agents, such as equine Alphaherpesvirus 3, the etiologic agent of equine coital exanthema, are observed (Silva-Filho et al. 2021). Infections by equine arteritis virus, various bacteria, and nematodes have also been associated with cases of epididymitis in horses (Snider 2015). We could not investigate the specific etiology of these low-occurrence MRTDs in the affected equids herein.



Fig.13-14. Horses with MRTDs. (13) Prepuce. Squamous papilloma. Prominent papillary proliferation of epidermis with marked acanthosis and orthokeratotic hyperkeratosis. HE, bar = 250µm. Inset: keratinocytes evidencing strong immunostaining for pan-cytokeratin (Immunoperoxidase, diaminobenzidine) IHC, bar = 250µm. (14) Right testis. Teratoma, gross aspect. Multilobulated and cystic neoplastic mass, firm, and tan to brown in color.

This study detected the most relevant MRTDs affecting over 7.5% of equids in a survey of 1,154 equids referred for hospital care. Our finding highlights that MRTDs may be debilitating and life-threatening conditions, and they can potentially impact the reproduction of equids in the region. This knowledge may support equine practitioners in elaborating proper sanitary and management protocols to prevent and reduce the incidence of most MRTDs recorded, improving equine production and welfare.

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