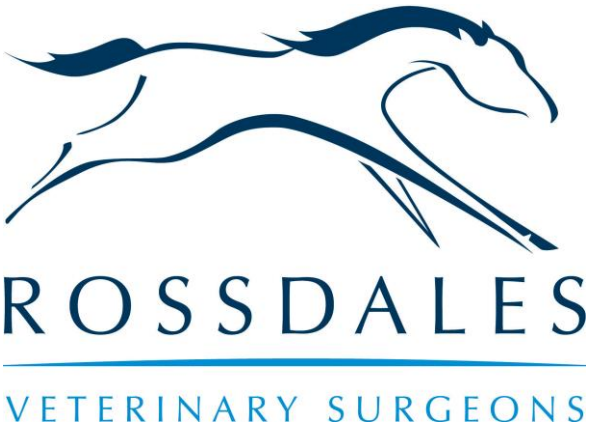
Research project
2015

Effect of Endoscopic Uterine Cyst Removal in 58 Thoroughbred Mares

Case studies (1998 – 2013), Newmarket, U.K.



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Content

Abstract

The breeding history of 58 Thoroughbred broodmares subjected to transendoscopic removal of uterine cysts between 1998 and 2013 was evaluated. Mean age of treated mares was 15.4 years. Number, size and distribution of the cysts in the uterus was taken into account in this study. Fertility status before and after surgery was compared for every individual. A postoperative pregnancy rate of 87.9% (51 out of 58 mares) was found and a live foal rate of 74.1% resulted the following year. Follow-up results of mares that did not produce a live foal in the first season after surgery showed that two out of 12 mares covered, remained barren in the second season after surgery. Six mares had a second or third procedure within three years after the first procedure to remove uterine cysts. In conclusion the pregnancy and live foal rates after surgery were high and comparable to those for normal fertile mares.

Introduction

Uterine cysts are fluid filled structures which can be categorized as lymphatic or glandular, depending on their origin. The cysts can occur anywhere in the normal or chronically inflamed endometrium (Kenney and Ganjam, 1975). Glandular cysts are embedded in the lamina propria and are caused by periglandular fibrosis (Kenney et al., 1975; Kenney, 1978). The size of glandular cysts varies from microscopic to less than one cm in diameter and they can be found in any area of the uterus (McKinnon et al., 1993; Wolfsdorf. n.d.). Glandular cysts are mostly incidental findings during examination or on histology (Wilson, 1985; Crespi and Werner, 1995). Glandular cysts are sometimes detected during pregnancy or in the periparturient period as a normal finding. These types of cysts are generally do not negatively influence fertility (McKinnon et al., 2011).

Uterine lymphatic cysts can be as small as several millimetres, and up to 20 cm in diameter and arise within the endometrium or myometrium (Kenney and Ganjam, 1975; Bracher et al., 1996). Formation of lymphatic cysts occurs due to blockage of endometrial lymph drainage vessels or a ventral collection of lymph in the uterus due to an enlarged gravid or post-partum uterus (Kenney and Ganjam, 1975; Stanton et al., 2004). Luminal lymphatic cysts protrude into the uterine lumen and are either pedunculated or with a broad base, are cylindrical or spherical in shape and arise in normal and most commonly arise in mares with CDE. When shown using ultrasound they appear as either uni-locular or multi-locular, whereas hyperechoic trabeculae are visible in multi-locular cysts in contradiction to uni-locular cysts (Ragon, 1996; Brinkso et al., 2011). In contrast to glandular cysts, these cysts are of sufficient size to interfere with establishment or maintenance of pregnancy (McKinnon et al., 2011).

Uterine cysts, glandular and lymphatic, can be present in sub-fertile and fertile mares. Uterine cysts detected by ultrasonography have been reported at incidences of between 5 and 27% in sub-fertile and fertile mares (Adams et al., 1987; Leidl et al., 1987; McKinnon et al., 1987; Torp, 1988; Eilts et al., 1995). When using hysteroscopy to diagnose and/or treat uterine cysts, prevalences of between 1.3 and 55% were reported in mares that were examined by hysteroscopy because they were considered infertile (Wilson, 1985; Brook and Frankel, 1987; Leidl et al., 1987; Bracher et al., 1992). Ragon reports that the incidence of lymphatic cysts in mares increases with age (Ragon, 1996). A significant effect of mare age on the presence of uterine cysts was reported among a group of 76 mares. Mares having uterine cysts were older; >14 years of age, compared to those without cysts; 7-14 years (Ferreira et al., 2008). Eilts determined in a study of 295 mares that mares older than 11 years of age were 4.2 times more likely to have uterine cysts than younger mares (Eilts et al., 1995).

The effect of the presence of uterine cysts on fertility is controversial. Uterine cysts may been proposed to have a possible influence on the mobility of the conceptus, resulting in failure of maternal recognition of pregnancy (Tannus and Thun., 1995; Ragon, 1996). Additionally, embryo development directly against a cyst instead of against normal endometrium may cause nutrient deprivation and as a result pregnancy loss may be more likely to occur (Tannus and Thun, 1995; Newcombe, 2000). Presence of uterine cysts has been associated with decreased foaling rates (Ragon, 1996). Significantly lower pregnancy rates at days 14 and 40 and higher embryonic death rates were reported in mares with cysts compared to mares without cysts (Chevalier-Clément, 1989; Tannus and Thun, 1995; Yang et al., 2007). By contrast, no significant influence on establishment and maintenance of pregnancy and on foetal losses due to the prevalence of endometrial cysts has also been reported (Chevalier-Clément, 1989; Eilts et al., 1995).

Uterine cysts can be removed in several ways: manually by squeezing, puncturing or using an obstetrical wire (Stanton et al., 2004). Two surgical methods, i.e., electrocoagulation and laser therapy, are described for removing endometrial cysts in the mare during hysteroscopy (Brook and Frankel, 1987; Blikslager et al., 1993). Electrocoagulation, also called surgical diathermy, is recommended for removal of large pedunculated uterine cysts. Laser therapy is more suitable for cysts that are broad-based or small and therefore more difficult to snare with a loop (Stanton et al., 2004). Moreover, laser therapy causes more extensive damage, including all uterine layers, whereas using an electrocautery loop only causes damage to the endometrium (Bartmann et al., 2003).

The aim of this study was to examine fertility of mares after surgical removal of uterine cysts by electrocoagulation or laser therapy in 58 mares during the years 1998 to 2013.

1. Material and methods

1.1 *Case description and definition*

Fertility of mares was compared before and after surgical removal of uterine cysts. The Newmarket Thoroughbred database (NTD) for the 58 mares showed surgeries were performed at any time of the year. Different situations regarding the covering of mares prior and post-surgery existed. Prior to treatment, a mare could have been barren for one or more years in a row or have had difficulty maintaining her pregnancy resulting in (early) abortion or a foal born dead. By contrast, other mares produced a live foal for one or several years, including the year of treatment. Month of surgery performed could be during the breeding season or in the non-breeding season. All mares were covered post-surgery; either in the same breeding season that surgery was performed in or in the subsequent breeding season.

Information about fertility of a mare and thus breeding history before and after surgery is defined using terminology of Weatherbys and presented in paragraph 1.3 *Mares variables*, section *Breeding history of a mare before and after surgery* (Weatherbys, 2014). Result of covering was defined as 'not pregnant' or 'pregnant'. Not pregnant mares were mares those that were not known to have been pregnant after covering at the first scan (day 14-16) i.e., negative pregnancy scan. Pregnant mares were pregnant at day 16 i.e., positive pregnancy scan. The pregnant mares included ones that subsequently suffered (early) abortion, still birth, foals that died shortly after birth and foals that survived. Some mares had more than one treatment to remove uterine cysts. To compare fertility before and after surgical removal of the cysts, only the first surgery was taken into account. Results of covers include covers on first, second or a later cycle. The above variety in scenarios regarding history of fertility, covering and pregnancy outcome can be summarized into four different scenarios (mare types A, B, C or D) and displayed in Table 1. The mares had a different history regarding their fertility before treatment:

- Type A mares: did not have a live foal in breeding season before treatment. These mares were covered in the current season prior to treatment, but the pregnancy scan was negative. These mares were classified as barren.

- Type B mares: also did not have a live foal in the breeding season before treatment. These mares were covered in the current season before treatment and were scanned pregnant. However, the mares did not produce a live foal and are classified as (early) aborted, dead foal or foal died shortly after birth for the breeding season before treatment.

- Type C mares: had a foal in the breeding season before treatment. These mares were covered again after foaling in the current breeding season and the scan was either negative or positive. These mares did not produce a live foal as a result of cover after foaling in breeding season before treatment and are classified as barren, (early) aborted, dead foal or foal died shortly after birth.

- Type D mares: these mares had a foal in breeding season before treatment. These mares were not covered before treatment in the current breeding season. If surgery was performed during the breeding season, some mares were covered after they were treated in the clinic.

Table 1: *Overview of different history of fertility of mares before treatment in NT database*

Type	Live foal in breeding season before treatment	Covered in breeding season before treatment	Outcome of cover before treatment	Outcome of pregnancy
A	No	Yes	Negative	Barren
B	No	Yes	Positive	Pregnancy loss
C	Yes	Yes	Positive or negative	Barren or pregnancy loss
D	Yes	No	Not applicable	Not applicable

In conclusion, comparison of fertility before and after surgery is defined as:

- Fertility before surgery: covering details of mares in breeding season based on their last covering details prior to surgery, categorized into mares type A, B, C or D.

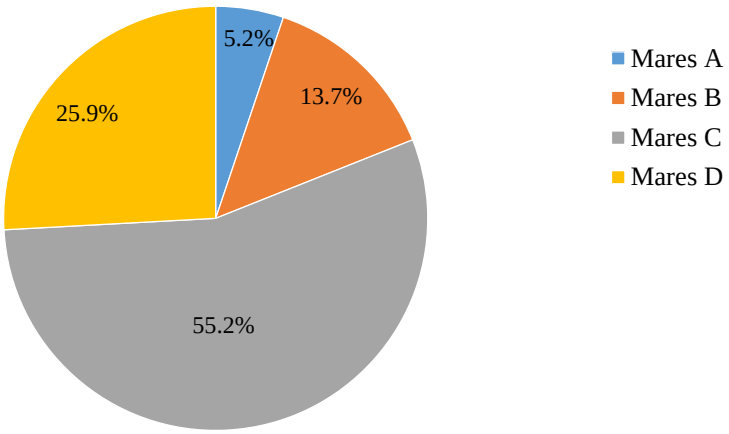
- Fertility after surgery: covering details of mares in breeding season based on their first covering details post surgery.

1.2 ***Newmarket Thoroughbred Database***

A total of 58 Thoroughbred mares were referred for surgical removal of uterine cysts to Rossdales Equine Hospital in Newmarket, United Kingdom. Surgeries to remove uterine cysts were performed from January to December between 1998 and 2013. Uterine cysts were removed for a variety of reasons. Examples are pregnancy loss during early and late gestation, owner requested removal because cysts could be mistaken for pregnancy and inability to conceive for one or a number of seasons prior to the referral. The evaluation of breeding history reports for every single mare showed that 56 out of 58 mares had a history of being barren, (early) abortion, foals born dead or died shortly after birth for at least one year in their stud career. Two mares did not have any history of fertility problems before surgery. One of these mares bred successfully for six years in a row and the other mare for 14 years.

Figure 1 illustrates the distribution of the mares over the categories A, B, C and D in the total Newmarket Thoroughbred database (NTD). The figure shows that 11 mares (18.9%) were labelled as either type A or type B. They did not have a living foal in the breeding season before surgery and the last cover before surgery did not result in a living foal. One exception in the database is a mare labelled as mare type B; she was not covered again after having a dead foal in the breeding season before treatment. 32 mares (55.2%) were labelled as type C, having produced a live foal in the last breeding season before surgery. They were unable to conceive or produce a living foal as the result of cover after foaling in the breeding season in which the surgery was performed. The database had 15 mares (25.9%), labelled as type D, i.e. that gave birth to a live foal in the breeding season of surgery. In contrast to type C mares they were not covered again after giving birth to their foal.

Figure 1: *Distribution of mares in database into A, B, C and D regarding their fertility history*



In the descriptive statistics, when referring to fertility status before and after surgery, mares that were not scanned pregnant at first pregnancy scan after covering were labelled 'not pregnant', i.e. groups A and part of group C. These mares were labelled as barren. Fertility status 'pregnant' were mares that had a positive early pregnancy scan, i.e. B, part of group C and D, but not all of these mares carried their foal to full term to produce a live foal. These included mares that suffered early abortions (before five months of pregnancy) and abortions after five months of pregnancy. Foals carried to term include live born foals, foals born dead or foals that died shortly after birth. In tables 3, 4 and 15 – 22 presented in the descriptive statistics this is further clarified by dividing 'pregnant' mares into 'pregnant (aborted-foal)', abbreviated as 'pregnant (a-f)'. Letters *a* and *f* correspond to the numbers of mares aborted or foaled. Example: pregnant (5-30) implies 35 mares were pregnant, five of them aborted and 30 mares carried their foal to term. Fertility status before and after surgery is summarized in Table 2.

Table 2: *Fertility status before and after surgery differentiated into pregnant and not pregnant*

Fertility status	Pregnancy scan	Mares
Not pregnant	Negative	Mares A and (partly) mares C
Pregnant (aborted-foal)	Positive	Mares B, (partly) mares C and mares D

1.3 *Mare variables*

The relevant variables of the mares used in this research project include *age, breeding history before and after surgery* and *presence of endometritis*. Also the *number of cycles covered to produce a live foal* and the *gestation length* are taken into account.

<u>Age</u>

Weatherbys database 'Mare's Progeny Listing' was used to determine the date of birth of mares and age on date of (first) surgery to remove uterine cysts (Weatherbys. Produce of Broodmare).

Breeding history of mares before and after surgery

Information about the stud career of a mare before and after surgery was found in Weatherbys Mare's Progeny's Listing', Equineline 'Mare's Produce Record Listing', by evaluating veterinary pregnancy scan results in the database of Rossdale's Equine Hospital and by approaching studs and owners (Equineline. Mare's Produce Record Listing; Rossdales Equine Hospital; Weatherbys. Produce of Broodmare). Fertility and stud career for every mare was analysed and categorized using Weatherbys terminology for each year as follows:

1. Barren: *'A mare which after covering is not known to have been pregnant shall be described as "barren".'*

2. Aborted early: *'A mare which after covering is certified as pregnant at 40-50 days (but was later tested empty) and aborts early, or does not have a foal so resorption/abortion is assumed shall be described as "aborted early".' This is a mare that lost her foal in the first 5 months of pregnancy.*

3. Slipped: *'A mare which after covering is certified pregnant and aborts after 5 months shall be described as "slipped".'*

4. Dead foal and foal died: *'A mare which after covering produced a foal either dead at birth or which died shortly after birth.'*

5. Not covered: *'A mare which was not covered the previous year shall be described as "not covered".'*

6. Live foal produced: (*date of birth*)

Presence of endometritis

Laboratory results from Rossdale's Equine Hospital were reviewed to identify mares with acute and/or chronic endometritis before and after surgery (Rossdales Equine Hospital). Results of endometrial swabs, smears and biopsies were evaluated for the period around surgical treatment. The results of endometrial biopsies were evaluated as part of the full clinical history up to first breeding season after surgery. Endometrial swabs, smears and uterine biopsies with regard to the presence of endometritis before and after surgery was not available for every mare. The presence of acute endometritis was evaluated via endometrial swabs and smears before and after surgery and was available for 21 and 27 mares, respectively. Results of uterine biopsies to determine the degree of acute and/or chronic infiltrative or degenerative endometritis for 24 and 28 mares were evaluated before and after surgery, respectively. This means that the presence of acute endometritis and/or chronic endometritis in the first season after surgery could be determined for 40 mares.

Interpretation of laboratory results of endometrial swabs and smears

Endometrial swabs present any bacterial (aerobic and/or microaerophilic culture) growth. Swabs revealed bacterial growth of *Escherichia coli, Staphylococcus aureus, Beta-haemolytic streptococci, Klebsiella pneumonia* and *Pseudomonas aeruginosa*. Possible isolation of *Taylorella equigenitalis* and presence of yeast of fungi was also mentioned. Endometrial smears evaluated cytology for the presence of polymorphonuclear neutrophils (PMNs), epithelial cells and debris. An acute endometritis was diagnosed if there were significant numbers of neutrophils in the smear (BEVA, 2002). Presence of PMNs in smears was categorized as: '0 and +/-' (no PMNs or <0.5% PMNs as % of all cells seen), '1+' (little

inflammation, 0.5% - 5.0% of PMNs), '2+' (moderate inflammation, 5.0 – 30% PMNs), '3+' (severe inflammation, >30% PMNs). Presence of a positive culture only from an endometrial swab without any cytological signs of inflammation, i.e., no PMNs, was taken to indicate contamination instead of an ongoing endometritis (BEVA, 2002). When the outcome of a swab showed no growth on culture or only one colony of bacterial growth in combination with no PMNs or +/- PMNs, the conclusion was that the mare was free of acute endometritis.

Interpretation of uterine biopsies

Through conducting uterine biopsies histological appearance of the endometrium could be evaluated. The biopsy results were categorized to include acute, chronic infiltrative endometritis and chronic degenerative endometritis (CDE). The type and severity of endometritis was further specified into low, moderate or severe and diffuse or focal. Chronic infiltrative endometritis was not considered pathologically significant whereas chronic degenerative endometritis, if present, was described in relation to the mare's age to determine whether it was 'acceptable'. This was noted as 'within acceptable limits', in addition to the histological result of the uterine biopsy.

Number of cycles covered to produce a live foal before and after surgery

Number of cycles to produce a live foal before and after surgery was collected from the veterinary clinic's database and if missing the relevant studs and owners were approached directly (Rossdale's Equine Hospital). Number of cycles was categorized as: 'one cycle', 'two cycles', 'three cycles' etcetera. Number of coverings per cycle was not taken into account. For example: a mare covered three times in total; once during her first cycle and twice during her second cycle and that eventually produced a live foal was documented as needing 'two cycles' to produce a live foal. The mares that produced a live foal in breeding season before surgery were type C and D mares in the database. Because it is not known when cysts were first noticed for every mare, only mares labelled as C and D were taken into account to determine the number of cycles to produce a live foal before surgery. For these mares, information about number of cycles covered to produce a live foal before surgery was available for 23 out of 47 mares. After surgery 43 of the NT database mares produced a live foal and information about number of cycles covered to produce a live foal after surgery was available for 24.

Gestation length of foals before and after surgery

Information about the gestation length was obtained by positive pregnancy scans from the veterinary clinic's database, Weatherbys 'Mare's Progeny's Listing' and by approaching studs and owners directly, if needed (Rossdales Equine Hospital; Weatherbys. Produce of Broodmare). Gestation length of foals was categorized as: 'short' (< 320 days), 'normal' (320 – 360 days) or 'long' (> 360 days) (Laing and Leech, 1975; Rossdale et al., 1984; Rossdale, 1993; Immegart, 1997). As mentioned earlier, the NT database included 47 mares labelled as C and D and these are taken into account to determine the gestation length of foals before surgery, because it is not known when cysts were first detected. Information about gestation length of foals before surgery was available for 24 mares. After surgery 43 mares produced a live foal, information about gestation length of foals was available for 24 mares.

1.4 *Surgical variables*

The relevant surgical variables include size of cysts, number of cysts and distribution in uterus. Treatment method and indication of whether all cysts could be removed successfully were also taken into account. Surgical details of mares were analysed through clinical reports and letters available at Rossdale's veterinary clinic (Rossdale's Equine Hospital). Missing details and reports were sometimes found by approaching surgeons who performed the surgery or in the database of mares studs. (In)complete reports for 56 mares were evaluated and for two mares no details could be evaluated due to missing reports. Surgeons did not use a set format to record these variables for a surgical procedure and therefore some clinical data are based on personal interpretation and not every variable was noted for every single mare.

Size of cysts

Surgeons reported size of cysts in two different ways; descriptive words or exact measurements. Words such as 'small', 'medium' and 'large' were used to describe size of diagnosed and/or removed cysts. If the size was written in exact measurements instead of words, the following measures were used to categorize the cysts into the following categories: '<1.5 cm'(small), '≥1.5 cm – 2.5 cm' (medium), '>2.5 cm' (large). Size of the biggest cyst was used in categorizing a mare that had multiple cysts present in her uterus.

Number of cysts

Clinical data showed numbers to mention the amount of cysts or an indication only such as 'multiple' or 'several'. Therefore, numbers of cysts were necessarily categorized as: 'one' and 'more than one'.

Distribution in uterus

Location of cysts in the uterus was divided into single or multiple locations: 'one or both horns', 'corpus-cornual junction', 'uterine body' and 'multiple locations'. Multiple locations included any combination.

Treatment method

Surgical removal of cysts could be performed by: 'electrocoagulation', 'laser therapy' or 'both methods'.

Surgical removal of cysts

Successful removal of all uterine cysts was categorized as: 'no' or 'yes'. Smoke and bleeding caused by the surgical procedure could make it difficult to remove all cysts. In addition, some cysts were surgically not accessible and could therefore not be removed. When a clinical report mentioned 'multiple' or an exact number of cysts removed, surgical removal was categorized as 'yes'. 'Multiple cysts' diagnosed followed by 'several removed' or 'unable to remove all cysts' was categorized as 'no'. Those mares that still had uterine cysts after surgery are marked with symbol '*' in tables of descriptive statistics. One mare had cysts again in the first breeding season after surgery, she is also marked with symbol '*'.

Section 2.2 *Follow-up of mares* presents the mares that did not have a live foal in the first breeding season after surgery.

2. Results

2.1 *Descriptive statistics*

2.1.1 Mare variables

Symbol '*number' in presented tables shows mares without successful removal of all uterine cysts during surgery. The NT database includes 12 mares without successful removal of all cysts. For example: *2 means two mares did not have all uterine cysts removed.

Age

Surgery to remove uterine cysts was performed on 58 Thoroughbred mares. Age of mares ranged from 5 – 24 years with an average of 15.4 ± 3.7 years on day of surgery. Three mares (5.2%) were in the age group 5 – 9 years, 21 mares (36.2%) in the age group 10 – 14 years, 29 mares (50%) in the 15 – 19 year group and 5 mares (8.6%) were 20 – 24 years. Table 3 shows the age of 58 mares on the day of surgery and differentiates between not pregnant or pregnant after surgery.

Table 3: *Age of mares on day of surgery and fertility after surgery*

Age in years	5 – 9	10 – 14	15 – 19	20 – 24
Number of mares (n = 58)	3	21	29	5
Number not pregnant (n = 7)	0	4*[1]	2*[1]	1
Number pregnant (n = 51) (aborted-foal)	3 (0-3)*[1]	17*[4] (2-15)	27*[3] (2-25)	4*[2] (0-4)

Breeding history of mares before and after surgery

Fertility results based on last covering details prior to surgery and first covering post-surgery is presented in Table 4. Evaluation of fertility before and after surgery using terminology of Weatherbys is as follows; 25 mares (43.1%) were reported as barren before surgery and seven (12.1%) after surgery. Before surgery 14 mares (24.1%) mares aborted before five months compared to four mares (6.9%) after surgery. Three mares (5.2%) lost their foal after five months before surgery and no mares lost their foal after five months after they were treated. No mares had a dead foal before surgery and one mare (1.7%) had a foal born dead post-surgery. Also one mare (1.7%) had a foal that was born alive, but died shortly after birth, followed by three mares (5.2%) post-surgery. 15 mares (25.9%) had a live foal before surgery and 43 mares (74.1%) had a live foal after surgery. In summary, prior to surgery 56.9% became pregnant with 25.9% producing a live foal. After surgery, 87.9% became pregnant, yielding a live foal rate of 74.1%.

Table 4: *Fertility comparison of mares before and after surgery*

Fertility	Before surgery	After surgery
Number not pregnant	25	7*[2]
Number pregnant (aborted-foal)	33 (17-16)	51 (4*[1]-47*[9])
Total	58	58

Presence of endometritis in barren and pregnant mares before surgery

Results about presence of endometritis before surgery evaluated through endometrial swabs, smears and uterine biopsies was differentiated for not pregnant or 'barren' mares in Table 5. An endometrial swab and smear was taken from 8 out of 25 barren mares before surgery. Two

mares had little evidence of inflammation. An uterine biopsy was taken for 11 out of 25 barren mares. Two mares had presence of (very low grade) acute endometritis in combination with chronic infiltrative endometritis. Out of six mares with chronic degenerative endometritis (CDE), four mares also had presence of (low grade or moderate) acute endometritis. Of three mares diagnosed with CDE it was considered within acceptable limits regarding their age.

Table 5: *Results about presence of endometritis before surgery of barren mares*

Fertility	Endometrial swab and smear	Result	Uterine biopsy	Result
Not pregnant n = 25	Taken n = 8 Not available or taken n = 17	No acute endometritis n = 6 PMNs 1+ n = 1 PMNs 2+ n = 1	Taken n = 11 Not available or taken n = 14	Chronic infiltrative endometritis n = 5 Chronic degenerative endometritis n = 6

Results for pregnant mares, which were further differentiated into live foal or no live foals, is presented in Table 6. An endometrial swab and smear was taken for 13 pregnant mares before surgery; cytology did not show any sign of an ongoing acute endometritis. Of nine out of 18 mares that did not produce a live foal before surgery an uterine biopsy was taken. For five out of seven mares diagnosed with CDE the biopsy was considered within acceptable limits regarding their age. For four out of 15 mares that did produce a live foal before surgery a biopsy was taken and all mares were diagnosed with CDE. For three of these mares the biopsy was considered within acceptable limits regarding their age.

Table 6: *Results about presence of endometritis before surgery of pregnant mares*

Fertility	Endometrial swab and smear	Result	Uterine biopsy	Result
Pregnant (aborted, slipped, dead foal and foal born dead) n = 18	Taken n = 8 Not available or taken n = 10	No acute endometritis n = 8	Taken n = 9 Not available or taken n = 9	Chronic infiltrative endometritis n = 2 Chronic degenerative endometritis n = 7
Pregnant (living foal) n = 15	Taken n = 5 Not available or taken n = 10	No acute endometritis n = 5	Taken n = 4 Not available or taken n = 11	Chronic infiltrative endometritis n = 0 Chronic degenerative endometritis n = 4

Presence of endometritis in barren and pregnant mares after surgery

Results about presence of endometritis after surgery is differentiated for not pregnant or 'barren' mares in Table 7. Cytology results taken from three out of seven barren mares did not indicate an ongoing acute endometritis. The result of an uterine biopsy taken of a barren mare after surgery showed acute endometritis in combination with chronic infiltrative endometritis. For one out of two mares diagnosed with chronic degenerative endometritis (CDE) the result was considered within acceptable limits for age.

Table 7: *Results for presence of endometritis after surgery of barren mares*

Fertility	Endometrial swab and smear	Result	Uterine biopsy	Result
Not pregnant n = 7	Taken n = 3 Not available or taken n = 4	No acute endometritis n = 3	Taken n = 3 Not available or taken n = 4	Chronic infiltrative endometritis n = 1 Chronic degenerative endometritis n = 2

Results of pregnant mares, further differentiated as having a live foal or not, is presented in Table 8. Cytology did not indicate an ongoing acute endometritis for five endometrial swabs taken from eight mares that did not produce a live foal. For four out of five mares diagnosed with CDE that did not produce a live foal after surgery the biopsy was considered within acceptable limits regarding their age. Cytology results for mares that had a live foal showed no sign of an ongoing acute endometritis for 17 out 19 mares examined, one mare had little inflammation and one mare colonies of *Beta-haemolytic streptococci*. Of 17 mares with CDE diagnosed after surgery that produced a live foal one mare had a (low grade) acute endometritis. For 15 out of 17 mares diagnosed with CDE the biopsy was considered within acceptable limits for age.

Table 8: *Results about presence of endometritis after surgery of pregnant mares*

Fertility	Endometrial swab and smear	Result	Uterine biopsy	Result
Pregnant (aborted, slipped, dead foal and foal born dead) n = 8	Taken n = 5 Not available or taken n = 3	No acute endometritis n = 5	Taken n = 5 Not available or taken n = 3	Chronic infiltrative endometritis n = 1 Chronic degenerative endometritis n = 4
Pregnant (living foal) n = 43	Taken n = 19 Not available or taken n = 24	No acute endometritis n = 17 PMNs 1+ n = 1 Colonies of *Beta-haemolytic streptococci* n = 1	Taken n = 20 Not available or taken n = 23	Chronic infiltrative endometritis n = 3 Chronic degenerative endometritis n = 17

Number of cycles covered to produce a live foal before and after surgery

- *Before surgery*

The mares that produced a live foal in the breeding season before surgery were type C and D mares in the NT database. Type A and B mares did not produce a live foal in the breeding season before surgery. As mentioned earlier, the database contained 47 mares categorized as C and D and information about number of cycles covered to produce a live foal before surgery was available for 23 mares. An average of 1.74 ± 1.03 cycles was required. 13 mares were successfully covered at their first cycle to produce a live foal. Six and one mare were covered on their second and third cycle respectively to produce a live foal. Three mares that were covered at more than three cycles were successfully covered on the fourth cycle.

- *After surgery*

The database shows 43 mares that produced a live foal in the breeding season after surgery. Of these mares information about number of cycles covered to produce a live foal before surgery was available for 24 mares with an average of 1.79 ± 1.15 cycles. Differentiation between one, two and three cycles is further presented in Table 9. One mare that was covered at more than three cycles was successfully covered on the sixth cycle. No information was available for 19 mares, including three mares that did not have all cysts removed during surgery. Four mares that did not have all cysts removed did not produce a live foal in the first season after surgery and are presented in section '2.2 *Follow-up of mares'*.

Table 9: *Mares related to number of cycles to produce a live foal after surgery*

Cycles	Number of mares
Cycle 1	13*[4]
Cycle 2	6*[1]
Cycle 3	4
More than three cycles	1

Gestation length of live produced foals before and after surgery

- *Before surgery*

Before surgery 47 mares had a live foal in the breeding season preceding treatment. Gestation length of live foals was available for 24 foals. A range from 331 to 366 days was found, mean 345.5 days and standard deviation ± 9.5. No information was available for 23 mares regarding covering dates and therefore no gestation length of foals could be determined. 22 mares produced live foals between 320 – 360 days. Two mares that had a pregnancy longer than 360 days carried their foal 363 and 366 days respectively.

- *After surgery*

After surgery, 43 mares produced a live foal. Of these mares, information about gestation length of foals after surgery was available for 24 foals. A range from 336 to 373 days was found, mean 352 days and standard deviation ± 10.4. No information was available for 19 mares regarding (exact time of) pregnancy scans and therefore no gestation length of foals could be determined, this includes three mares that did not have all cysts removed. Table 10 further clarifies classification about the duration of the pregnancies. Five mares that had a pregnancy longer than 360 days carried their foal 360, 364, 369, 371 and 373 days respectively. Of five out of 12 mares that did not have all cysts removed information about gestation length of foals was available. Four out of 12 mares that did not have all cysts removed did not produce a live foal in the first season after surgery and are presented in section '2.2 *Follow-up of mares'*.

Table 10: *Gestation length of live produced foals after surgery*

Gestation length	Number of foals
Short < 320 days	0
Normal 320 – 360 days	19*[5]
Long > 360 days	5

2.1.2 Surgical variables

Size of cysts

In summary, six mares (10.3%) had 'small' cysts reported or at least smaller than 1.5 cm. Eight mares (13.8%) had cysts larger than 1.5 – 2.5 cm or reported as 'medium' and 31 mares (53.5%) had cysts larger than 2.5 cm or reported as 'large'. Of 13 mares (22.4%) the size of cysts was not recorded. In Table 11 and 12 fertility status of mares before and after surgical removal of cysts regarding size of cysts is presented.

Table 11: *Fertility status before surgery and size of cysts*

Fertility	Small <1.5 cm	Medium ≥1.5 – 2.5 cm	Large >2.5 cm	Not available	Total
Number not pregnant	3	5	10	7	25
Number pregnant (aborted-foal)	(2-1)	(2-1)	(11-10)	(2-4)	33
Total	6	8	31	13	58

Table 12: *Fertility status after surgery and size of cysts*

Fertility	Small <1.5 cm	Medium ≥1.5 – 2.5 cm	Large >2.5 cm	Not available	Total
Number not pregnant	0	0	4*[2]	3	7
Number pregnant (aborted-foal)	(1-5*[1])	(0-8*[1])	(2*[1]-25*[5])	(1-9*[2])	51
Total	6	8	31	13	58

Number of cysts

In summary four mares (6.9%) had only one uterine cyst recorded. 47 mares (81.0%) had at least two cysts and for seven mares (12.1%) the number of cysts is not known. In Table 13 and 14 fertility status of mares before and after surgical removal of cysts regarding number of cysts is presented.

Table 13: *Fertility status of mares before surgery and number of cysts*

Fertility	One	More than one	Not available	Total
Number not pregnant	2	19	4	25
Number pregnant (aborted-foal)	(0-2)	(16-12)	(1-2)	33
Total	4	47	7	58

Table 14: *Fertility status of mares after surgery and number of cysts*

Fertility	One	More than one	Not available	Total
Number not pregnant	0	5*[2]	2	7
Number pregnant (aborted-foal)	(0-4)	(3*[1]-39*[9])	(1-4)	51
Total	4	47	7	58

Distribution in uterus

In summary 17 mares (29.3%) had cysts found in one location in the uterus: ten mares (17.2%) in one or both horns, four mares (6.9%) near the corpus-cornual junction and three mares (5.2%) in the uterine body. 28 mares (48.3%) had cysts in more than one location and of 13 mares (22.4%) the location of cysts was not available. In summary, in this group of mares 43.1% of cysts were found in the left uterine horn, 39.7% in the right horn, 37.9% at the corpus-cornual junction and 37.9% in the uterine body. In Table 15 and 16 fertility status of mares before and after surgical removal of cysts regarding distribution in uterus is presented.

Table 15: *Fertility status of mares before surgery and distribution of cysts in uterus*

Fertility	One or both horns	Corpus-cornual junction	Uterine body	Multiple locations	Not available	Total
Number not pregnant	5	2	2	9	6	25
Number pregnant (aborted-foal)	(0-5)	(1-1)	(0-1)	(12-7)	(4-3)	33
Total	10	4	3	28	13	58

Table 16: *Fertility status of mares after surgery and distribution of cysts in uterus*

Fertility	One or both horns	Corpus-cornual junction	Uterine body	Multiple locations	Not available	Total
Number not pregnant	1	0	0	3*[2]	3	7
Number pregnant (aborted-foal)	(0-9*[2])	(0-4)	(0-3*[1])	(3*[1]-22*[3])	(1-9*[3])	51
Total	10	4	3	28	13	58

Treatment method

In summary 48 mares (82.8%) had cysts removed by electrocoagulation/surgical diathermy, two mares (3.4%) by laser therapy and three mares (5.2%) through both methods. For five mares (8.6%) it was not known how cysts were removed. Of one mare it has been reported that she had some cysts manually squeezed before the surgical removal by diathermy at Rossdale's Equine Hospital.

Surgical removal of cysts

In summary 12 mares (20.7%) did not have all cysts removed, 35 mares (60.3%) had their cysts successfully removed and for 11 mares (19.0%) it was not known if all cysts were removed. Four mares out of 12 that did not have all cysts removed did not have a live foal in the first breeding season after surgery. A second surgery to remove cysts was reported for six out of 58 mares (10.3%) within three years after the first treatment. In Table 17 fertility status of mares after surgical removal of cysts regarding successful removal is presented.

Table 17: *Fertility status of mares after surgery and successful removal of cysts*

Fertility	No	Yes	Not available	Total
Number not pregnant	2	2	3	7
Number pregnant (aborted-foal)	(1-9)	(2-31)	(1-7)	51
Total	12	35	11	58

2.2 *Follow-up of mares*

Fertility status in second season after surgery and presence of endometritis

The follow-up of mares includes those in the database that did not produce a live foal after surgical removal of uterine cysts. Therefore results regarding fertility of these 15 mares (25.9%) with different fertility histories and categorized into mares type A, B, C and D are presented in Table 18. The table shows their covering details in the first season and second season after surgery. Four out of these 15 mares did not have all cysts removed.

Age of mares ranged from 10 – 22 years with an average of 15.1 ± 3.2 on day of surgery. Seven mares were barren in the first season after surgery; six of them were covered in the second season after surgery and one mare died. Four out of these six mares had a live foal and two mares remained barren. Four mares aborted early in the first season after surgery, but in the second season they all had a live foal. Of two out of these four mares swab and/or smears were taken and cytology results showed no acute endometritis. Uterine biopsy results were available for three mares; one mare was diagnosed with chronic infiltrative endometritis and two mares with CDE which for one mare was considered to be within acceptable limits for age. One mare had a foal born dead in the first season after surgery and in the second season she had a live foal. An endometrial swab and smear taken in season after surgery did not show any sign of an ongoing endometritis. Three mares had foals that died shortly after birth in the first season after surgery. In the second season two mares died and one mare had a live foal. No results regarding swab, smear and/or biopsy was available in second season after surgery of the mare that had a live foal.

Table 18: *Fertility in first and second season (follow-up) after surgery*

Fertility	First season after surgery	Second season after surgery
Barren	7*[2]	2
Aborted foal	4*[1]	0
Dead foal	1	0
Foal died	3*[1]	0
Living foal	0	10
Total	15	12

Number of cycles covered to produce a live foal in the second season (follow-up) after surgery

In the second season after surgery 10 out of 12 mares covered produced a live foal. Three mares died, and two mares were remained barren. Information about number of cycles covered to produce a live foal in the second season after surgery was available for seven mares with an average of 2.29 ± 1.28 cycles. No information was available for three mares, including one mare that did not have all cysts removed. Differentiation between one, two and three cycles of the seven mares is further presented in Table 19. Two mares that were covered at more than three cycles were successfully covered on the fourth cycle.

Table 19: *Mares related to number of cycles to produce a live foal after surgery*

Cycles	Number of mares
Cycle 1	3*[1]
Cycle 2	1*[1]
Cycle 3	1
More than three cycles	2

Gestation length of foals in second season (follow-up) after surgery

Information about gestation length of foals after surgery was available for seven out of 10 foals. A range from 336 to 355 days of gestation length was found, mean 346.7 days and standard deviation ± 6.3. No information was available for three mares regarding (exact time of) pregnancy scans, including one mare that did not have all cysts removed. Another mare that did not have all cysts removed died in the second season after surgery. Table 20 further clarifies classification about the duration of the pregnancies.

Table 20: *Gestation length of live produced foals in second season (follow-up) after surgery*

Gestation length	Number of foals
Early < 320 days	0
Normal 320 – 360 days	7*[2]
Long > 360 days	0

3. Discussion

3.1 Mares variables

Before the advent of hysteroscopy or ultrasonography, presence of endometrial cysts was usually found at necropsy. Kaspar et al. (1987) applying necropsy found in a study of 104 mares having endometrial cysts that all mares were older than ten years of age. Wilson (1985) and Bracher et al. (1992) used hysteroscopy entirely or as an adjunct to diagnose endometrial cysts and found mares less than ten years old with cysts. Adams et al. (1987) reported that the mean age of mares with endometrial cysts was 13.4 years of age. Furthermore, Eilts et al. (1995) referring to a study done among 215 mares stated that mares above the age of 11 years are 4.2 times more likely to have cysts than mares of 11 years or below. Ragon (1996) also showed that the incidence of lymphatic cysts in sub-fertile and fertile mares increases with age. For the presence of uterine cysts, Ferreira et al. (2008) reported a significant difference in a group of 76 mares: mares with cysts were older than 14 years while those without cysts ranged from 7 – 14 years of age. Griffin and Bennett (2002) found a mean cyst-occurrence age of 18.8 years in a group of 55 mares that had been barren for at least one breeding season. The average age of the 58 mares in the NT database was 15.4 ± 3.66 on day of surgery, with a range from 5 – 24 years. A total of 51 out of 58 mares were between 10 – 19 years old on the day of surgery. In other words, the average score and distribution regarding age of mares with cysts correlates with findings presented in the other reports mentioned above.

Adams et al. (1987), Bracher et al. (1992) and Ricketts and Alonso (1991) all claim that endometrial cysts are closely associated with increasing age and uterine biopsy scores showing degenerative changes. Dybdal et al. (1991) described that mares with cysts tend to have a higher biopsy grade in comparison to mares without cysts. Köllmann et al. (2008) evaluated 205 uterine biopsies taken post-operatively from barren mares that had hysteroscopic removal of uterine cysts. These biopsies were analysed and classified into grade I, IIa, IIb or III according to Kenney and Doig (1986). The expected foaling rates are approximately 80 – 90% in category I, 50 – 80% in category IIa, 10 – 50% in category IIb and under 10% in mares with category III. Köllmann et al (2008) found the following results: category I: 8.7%, category IIa: 34.1%, category IIb, 35.6% and category III: 21.4% Furthermore these uterine biopsies showed a higher percentage of chronic degenerative changes rather than signs of endometritis. In the Newmarket Thoroughbred database, a total of 27 out of 58 mares underwent an endometrial swab and/or smear following surgery to check for the potential presence of acute endometritis. 25 mares did not have any signs of acute endometritis, while one mare showed little inflammation (PMNs +1) and one mare had colonies of *Beta-haemolytic streptococci.* Furthermore, uterine biopsies of 28 mares were taken and all of these mares were diagnosed with different grades of CDE; the age of these mares ranged from 9 to 24 years old. Two out of these 24 mares showed presence of (a low grade of) acute endometritis in combination with chronic infiltrative endometritis and CDE. The finding of a minimal presence of acute endometritis is similar to results presented by Köllmann et al. (2008). 23 out of 28 mares were diagnosed with CDE which correlates to other publications relating to uterine biopsy scores showing degenerative changes. However, for 20 out of these 23 mares the biopsy was considered to be within acceptable limits for age. And therefore also support Adams et al. (1987) who did not find a statistical relationship between cysts and biopsy scores between mares with and without cysts.

Vesicle fixation, conceptus mobility and placentation may all be affected by the presence of uterine cysts as reported by Ginther (1986), McDowell et al. (1988), Tannus and Thun (1995), Ragon (1996) and Ittersum (1999). McKinnon et al. (1993) postulated that contact between

the cyst wall and yolk sac or allantois may prevent absorption of nutrients and Tannus and Thun (1995) and Newcombe (2000) added that, as a result, pregnancy loss is more likely to occur. Significantly higher frequencies of embryonic deaths and lower pregnancy rates were found by Chevalier-Clément (1989), Tannus and Thun (1995) and Yang et al. (2007) between 14 and 40 days of pregnancy in mares with cysts compared to mares without cysts. By contrast, no significant difference in fertility due to prevalence of endometrial cysts was reported by Eilts et al. (1995) and Chevalier-Clément (1989) did not find a significant difference in fetal loss for days 44 to 320 of pregnancy. Results regarding fertility in the NT database show a difference in mares able to conceive i.e. a positive pregnancy scan before and after surgery. 43.1% mares were reported as barren and 29.3% mares aborted before surgery compared to 12.1% of mares reported as barren and 6.9% mares that aborted after surgery. Before surgery a pregnancy rate of 56.9% was achieved and a live foal rate of 25.9%. The pregnancy rate after surgery was 87.9% and the live foal rate was 74.1%. For the NT database, the mean number of cycles to produce a live foal before surgery was 1.73 for 22 foals and after surgery, for 23 foals, 1.78. Brück et al. (1993) reported a mean number of 2.32 cycles per foal for 1,129 Thoroughbred mares and Hemberg et al. (2004) found in a study of 430 Thoroughbred mares a mean score of 1.86 to produce a live foal. Griffin and Bennett (2002) in a follow-up of two separate groups of mares that had uterine cysts removed mentioned these were bred at an average of 2.3 and 1.4 cycles per conception, respectively. These scores of the NT database are in between reported means of cycles in other studies of mares that did or did not have uterine cysts removed. However the live foal rate before and after surgery was very different. This difference in mares reported as barren, aborted and producing a live foal before and after surgery correlates well with other publications that state that cysts have an influence on fertility.

Gestation length in the mare is influenced by breed, which is an external foetal factor, reported by Jöchle (1957), Salerno and Montemurro (1965) and Pérez et al. (2003). Sivakumar et al. (2014) gave a gestation length of foals ranging from 320 to 365 days for a group of 56 Thoroughbred mares. A mean gestation length of 339 and 344.1 days of Thoroughbred foals pregnancies was reported by Whitwell and Jeffcott (1975), Rossdale and Ricketts (1980) and Davies Morel et al. (2002). However, 20% of Thoroughbred mares experience a prolonged gestation length of more than 355 days, based on foalings in the 2010 season of 7,588 mares in Ireland and 2,665 in the UK as reported by Equilume (2010). Eilts et al. (1995) found in a study of 286 mares no significant effect of cysts on establishing pregnancy or maintaining an established pregnancy to term. The mean gestation length of 23 foals in the NT database before mares had surgery was 346.1 days. After surgery the mean gestation length for 23 foals was 352.2 days. Gestation length before and after surgery ranged from 331 to 373 days. The average and range of gestation length in days before and after surgery are close to the days of gestation length of Thoroughbred foals reported elsewhere. Because of a variation in number of mares that (early) aborted and had a live produced foal before and after surgery as described above, it could be that cysts have an influence on establishing a pregnancy or maintaining a pregnancy to term. Therefore results of this NTD do not agree with the findings of Eilts et al. (1995) that there is no influence on establishing or maintaining a pregnancy to term.

3.2 Surgical variables

Kaspar et al. (1987) found that sporadically occurring cysts were about 1.1 cm in diameter, an average value of 0.5 cm in multiple cysts and the largest cyst was 3.0 cm in diameter. Eilts et al. (1995) evaluated the size of cysts and found an average of 1.3 cm with a range from 0.5 to 2.0 cm. Tannus and Thun (1995) found a range from 0.3 to 4.8 cm in size and suggest a

correlation between larger cysts, ≥ 2.5 cm, and mares older than 16 years. Bartmann et al. (2008) found a maximum diameter of intrauterine cysts of 5.8 cm. Ferreira et al. (2008) separated mares in two groups; mares with a small uterine cystic area (≤ 275 mm^2) and mares with a large uterine cystic area (≥ 410 mm^2). The average diameter score for mares with a small and a large cystic area were 0.56 cm and 0.79 cm, respectively. Ginther (1986) reported that small cysts do not adversely affect fertility. Wolfsdorf (n.d.), however, recommended cyst removal for mares with numerous small cysts that may prevent early embryonic growth or severely compromise the placenta. Brook and Frankel (1987) and Tannus and Thun (1995) showed some cases in which the presence of large endometrial cysts appeared to impede mobility of the embryonic vesicle, possibly blocking maternal recognition of pregnancy. Bracher et al. (1996) added that large cysts, if located superficially, may reduce placental exchange, leading to inadequate placentation and potentially abortion and Wolfsdorf (n.d.) also recommended treatment for mares with large cysts. A Wisconsin study cited by Brinkso et al. (2011) found a tendency for mares with cysts > 1 cm to have lower 40-day pregnancy rates than mares with smaller cysts. Brinkso et al. (2011) suggest that removal of cysts is seldom necessary if cysts are small i.e. ≤ 2 to 3 cm in diameter. Surgical details for 56 mares in the NT database were evaluated. (In)complete reports mentioned 10.3% mares that had small cysts, < 1.5 cm, 13.8% mares that had medium cysts, ≥ 1.5 – 2.5 cm and 53.5% mares with cysts bigger than 2.5 cm. For 22.4% of the mares that were treated the size of cysts was not known. Size of the biggest cyst reported was 7 cm. Although, it is not possible to calculate an average size of cysts for the entire NT database, the cysts tended to be larger than noted in other reports and therefore come closest to findings of Bartmann et al. (2008). In the NT database five out of six mares with fertility problems and small cysts removed all produced a live foal, which does not support Ginther (1986), who reported that small cysts do not adversely affect fertility. Still, there may have been other reasons why the mares failed to produce a foal previously. A total of 21 out of 31 NTD mares that had large cysts did not produce a live foal before surgery but were scanned barren or aborted before five months of pregnancy. This supports suggestions of Brook and Frankel (1987), Tannus and Thun (1995), Bracher et al. (1996) and Brinkso et al. (2011) that cysts can lead to early pregnancy loss.

Eilts et al. (1995) found a mean of 2.7 cysts present per mare in a group of 51 mares. Tannus and Thun (1995) found a range from one to seven cysts present per mare and suggested that in some cases the presence of numerous cysts could block maternal recognition of pregnancy. Bracher et al. (1992) found a negative correlation between a minimum of five cysts present and foaling rate. In another study by Bracher et al. (1996) they reported that multiple cysts if located superficially, may reduce placental exchange, leading to inadequate placentation and potentially abortion. Wolfsdorf (n.d.) recommends surgical treatment for mares that have numerous small cysts. Griffin and Bennett (2002) conducted a follow-up study on two groups that were treated for cysts. Both groups were divided in two subgroups of mares that did conceive and did not conceive following surgery. The first group of 25 mares had an average of six cysts in mares that did conceive and an average of five cysts in mares that did not conceive. In the second group of 14 mares that conceived had an average of seven cysts and the mares that did not conceive an average of four cysts. The outcome of the first group does not support the expectation that a higher number of cysts correlates with lower conception rates. Ferreira et al. (2008) reported that individual cysts were fewer in number with an average of 4.5 cysts in a small cystic area than in a large cystic area with an average of 18.3 cysts. Furthermore, Ferreira et al. (2008) differentiated between internal and external cysts projecting outward from the endometrium and found external cysts were present in lower numbers than internal cysts. Bartmann et al. (2008) found the largest number of cysts per mare was 24. In the NT dataset 6.9% mares had only one cyst examined in their uterus, 81.0%

mares had at least two or more examined and for 12.0% mares the number of cysts is not known. The highest number of cysts removed during surgery was reported to be 15. Because of the necessity in this study to categorize the frequency of occurrence of cysts into ‘one’ or ‘more than one’ it is not possible to compare results with other findings regarding exact number of cysts and fertility. Consequently it was not possible to reach a clear advice concerning the number of cysts for which surgery should be recommended.

Tannus and Thun (1995) found a predilection for cysts located at or near the base of both horns and Bracher et al. (1992) reported a predilection for larger cysts at the base of the right horn in 259 and 48 mares, respectively. Eilts et al. (1995) reported a distribution of cysts in uterus of 63 mares as follows: 35.6% in left uterine tip and base of horn, 67.3% in right uterine tip and base of horn and 17.5% in uterine body. Griffin and Bennett (2002) found a distribution of cysts of 21.6% in left horn, 28.2% in right horn, 16.4% at the corpus-cornual junction and 33.8% of cysts in uterine body. Ferreira et al. (2008) found that the frequency of both internal and external cysts was lower in the extremities than in central segments of the uterus. Furthermore, the corpus-cornual junction was more affected by internal than external cysts. Brinkso (2011) reports a possible predilection for cysts at the corpus-cornual junction. In contradiction to other studies Kaspar et al. (1987) based on 104 mares concluded that cysts did not have a location predilection for uterine body or horns. For the NT database it was established that when mares had cysts in one part of the uterus, the distribution was: 17.2% of mares had cysts in one or both horns, 6.9% mares near the corpus-cornual junction and 5.2% in the uterine body. Cysts were found in more than one location for 48.3% of the mares and of 22.4% of the mares the location of cysts was not available. In summary, 43.1% of cysts were found in left uterine horn, 39.7% in right horn, 37.9% at the corpus-cornual junction and 37.9% in uterine body. These results correlate with the distribution of cysts as reported by Griffin and Bennett (2002) more so than previous studies which suggested a higher prevalence of cysts in the caudal portion of the uterine horns. Brinkso (2011) noted that embryo fixation occurs usually at the base of one horn and recommends removal of cysts if they are grouped together at the corpus-cornual junction. In the NT database 34 mares had cysts in the horns only or in the horns in combination with another location of the uterus. Before surgery 9 out of these 34 mares and after surgery 28 out of 34 mares produced a live foal, respectively. A total of 22 mares had cysts at the corpus-cornual junction only or at the corpus-cornual junction in combination with another location of the uterus. Before surgery 6 out of these 22 mares and after surgery 17 out of 22 mares produced a live foal, respectively. The fact that there is a difference in mares that produced a live foal before and after surgery regarding the location of the cysts in the uterus supports Brinkso (2011) to recommend removal of cysts if they are grouped together at the corpus-cornual junction or horns.

Bartmann et al. (2003) claim that when removing uterine cysts, laser therapy causes damage to all uterine layers in contradiction to a diathermy loop which only causes damage to the endometrium. The NTD saw 82.8% of mares treated with diathermy, 3.4% with laser therapy and 5.2% with both methods. Of 8.6% mares it was not known how cysts were removed. Mares of the NTD that were scanned barren or aborted after surgery were all treated with electrocoagulation. Allen et al. (1997) achieved a pregnancy rate of 82% followed by 50% that gave birth to a live foal in 22 barren Thoroughbred mares treated with laser ablation. Bartmann et al. (1997) reached a pregnancy rate of 66% after hysteroscopic electro surgery in a study of 66 mares and Ittersum (1999) found a pregnancy rate of 60% in five mares treated with electrocoagulation. In a study of 222 barren mares with cysts and 185 mares able to follow-up in the following breeding season Köllmann et al. (2008) conveyed a pregnancy outcome of 79% undergoing endouterine surgery. The gestation percentage and live foal rate

in the NT database is higher than in other studies of mares that had uterine cysts removed. Stanton et al. (2004) reported that the most common problem in the treatment of cysts has been recurrence and they state that electrocautery, laser therapy and mechanical removal of the entire cyst seem to have the most consistent efficacy for long-term correction of the problem. Köllmann et al. (2008) mentioned a cyst recurrence of 33.8% in years following treatment of 60 out 177 mares. They recommend a follow-up treatment in mares with cyst recurrence. In the NTD a second surgery to remove cysts was reported for 10.3% mares within three years after the first treatment. It is possible that this number might be higher because, for example, mares had cysts that recurred but were not reported or mares that left the stud and therefore their follow-up history could not be recorded.

In summary, the average age and distribution of mares with cysts in the NTD correlates with findings in other reports. Also, the findings regarding acute endometritis and chronic degenerative endometritis in this study match with other publications that concluded that cysts associated with uterine biopsy scores show degenerative changes rather than signs of acute endometritis. However the uterine biopsies in most of the mares were considered to be within acceptable limits for their age and therefore it is difficult to state that these findings are really significant. Results regarding number of mares that were scanned barren, aborted or had a live foal before and after surgery are divergent. This supports the fact that surgical removal of cysts has a positive influence on fertility, but to really prove this a control group is needed. The mean of cycles to conceive and produce a live foal before and after surgery were in between reported means of cycles in studies of mares that did have uterine cysts removed. There is a possibility that cysts have an influence on establishing or maintaining a pregnancy to term because of the diversity in number regarding barren and aborted mares before and after surgery. This NTD supports findings that small and large cysts have an influence on fertility. However it is not possible to determine exact sizes or numbers and advise removing uterine cysts because of differences in documented reports of surgical treatments. Distribution of cysts in the NTD is different to previous reports that suggest cysts have a predilection location in the uterus, because distribution of cysts was almost equal in every location. The pregnancy and live foal rate was higher than in other studies of mares that were treated for uterine cysts. No mares that were treated through laser therapy or in combination with electrocoagulation were scanned barren after surgery. It is not possible to state laser therapy doesn’t have a negative effect on fertility after surgery, because only five mares were treated with laser therapy only. Furthermore recurrence of cysts has been noted also in this database as mentioned in literature.

Conclusion

In summary, 58 sub-fertile and fertile Thoroughbred mares had surgical removal of uterine cysts by electrocoagulation, laser therapy or both methods at Rossdale's Equine Hospital, Newmarket between 1998 and 2013. When treating uterine cysts it is important to remark that removal does not solve the primary problem and that cysts may return. Furthermore, because of the association of cysts with increasing biopsy scores it is difficult to determine the specific effect of cysts alone on fertility and mares with cysts can establish and maintain a pregnancy to term. Distribution of cysts in the uterus of treated mares was reported for 45 mares as follows: 43.1% in left horn, 39.7% in right horn and 37.9% for corpus-cornual junction and uterine body. Before surgery the pregnancy rate and live foal rates for 58 mares were 56.9% and 25.9%, respectively. After surgery a pregnancy rate of 87.9% and a live foal rate of 74.1% was achieved, and is higher than reported in previous studies of mares that had uterine cysts removed. Because of this, it is concluded that in combination with follow-up of mares in second breeding season after treatment, removal of uterine cysts may have a positive influence on fertility.

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