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Mare and foal survival and subsequent fertility of mares treated for uterine torsion

T. J. P. SPOORMAKERS*, E. A. M. GRAAT[†], F. TER BRAAKE[‡], T. A. E. STOUT[§#] and H. J. BERGMAN[†]

Lingehoeve Diergeneeskunde, Lienden, The Netherlands
[†]Quantitative Veterinary Epidemiology Group, Wageningen Institute of Animal Sciences (WIAS), Wageningen University, Wageningen, The Netherlands
[‡]Equine Referral Centre Emmeloord, Emmeloord, The Netherlands
[§]Department of Equine Health, Utrecht University, Utrecht, The Netherlands
[#]Department of Animal Reproduction, University of Pretoria, Pretoria, South Africa.

*Correspondence email: tjpspoormakers@gmail.com; Received: 11.02.14; Accepted: 01.01.15

Summary

Reasons for performing study: Previous surveys have reported that mare and foal survival after correction of uterine torsion (UT) varies from 60 to 84% and from 30 to 54%, respectively. Furthermore, resolution via a standing flank laparotomy (SFL) has been associated with better foal, but not mare, survival.
Objectives: To compare the success of SFL with other correction methods (e.g. midline or flank laparotomy under general anaesthesia; correction *per vaginam*).
Study design: Retrospective analysis of clinical records.
Methods: Data on correction technique, stage of gestation, degree of rotation, survival and subsequent fertility for 189 mares treated for UT at 3 equine referral hospitals in The Netherlands during 1987–2007 were analysed.
Results: Mean stage of gestation at diagnosis was 283 days (range 153–369 days), with the majority of UTs (77.5%) occurring before Day 320 of gestation. After correction of UT, 90.5% of mares and 82.3% of foals survived to hospital discharge, between 3 and 39 days later, and to foaling. Multivariable logistic regression indicated that correction method and stage of gestation at UT affected survival of foals and mares. For foals, survival was 88.7% after SFL compared with 35.0% after other methods (P = 0.001). When UT occurred at <320 days, 90.6% of foals survived, compared with 56.1% at ≥320 days (P = 0.007). For mare survival, an interaction between stage of gestation and correction method was detected (P = 0.02), with higher survival after SFL (97.1%) than other methods (50.0%) at <320 days of gestation (P<0.01). When UT occurred at ≥320 days, mare survival did not differ between techniques (76.0 vs. 68.8%; P = 0.6). Of 123 mares that were bred again, 93.5% became pregnant; fertility did not differ between mares treated by SFL (93.9%) and other techniques (87.5%; P = 0.9).
Conclusions: Standing flank laparotomy is the surgical technique of choice for resolving uncomplicated equine UT (i.e. with no coexisting gastrointestinal lesions) except when the stage of gestation exceeds 320 days.

Keywords: horse; uterine torsion; colic; standing; flank laparotomy

Introduction

Uterine torsion (UT) is an infrequent occurrence and an uncommon cause of equine dystocia, involving rotation of the gravid uterus by 180–540°, and appears to be more common in draught than in light horse breeds [1,2]. Mares with UT generally present with mild, often intermittent signs of abdominal pain [3]. While occasional mares present with more severe colic, the typically mild clinical presentation explains why there is often a delay of 3 h to 3 days or more [2,4,5] between the onset of abdominal discomfort and establishment of the diagnosis. Rectal palpation is the only way to confirm or rule out UT [4], and prompt intervention to correct the rotation will improve the prognosis [2]. Determining the direction of rotation is essential for treatment, which involves rotating the foal and surrounding uterus back in the opposite direction.

A variety of nonsurgical and surgical techniques for correcting UT have been described. In the foaling mare, it is sometimes possible to correct UT by rocking the foal back and forth through the dilated cervix [6–8]. In mares that are not close to term, rolling the anaesthetised mare in the direction of the rotation while holding the fetus and uterus still by pressure applied through the abdominal wall is a nonsurgical option. Beyond failure to resolve UT, reported complications of rolling include uterine rupture, premature placental separation, fetal death, abortion and premature delivery [6,8,9]. Ventral midline laparotomy is indicated in mares showing clear signs of readiness for birth [4], when uterine rupture or rotation of >360° is suspected, when the mare has severe pain suggesting gastrointestinal involvement or other complications or when UT cannot be corrected by standing flank laparotomy [4,10]. For mares not expected to foal for some time, correction via ventral midline [11–14], recumbent flank [6–8,15] and standing flank laparotomy [4,6–8,13,15,16] have all been described; irrespective of the technique used, correction of UT becomes more difficult as the mare gets closer to term because of the increasing size and weight of the fetus [3,17].

In the 3 largest retrospective studies following UT correction, mare survival rates were, respectively, 60% [8], 73% [4] and 84% [18] and foal survival rates 30% [8], 53% [4] and 54% [18]. Chaney *et al*. [18] reported that correcting UT by standing flank laparotomy (SFL) was associated with an improved likelihood of foal, but not mare, survival, and 19% [4] and 67% [18] of mares were successfully rebred in the breeding season following treatment for UT.

The present retrospective study, examining mare and foal survival and the outcome of subsequent breeding attempts following treatment for UT, aimed to generate evidence on which to base prognosis and to help guide the choice of correction technique.

Materials and methods

Clinical records were collated for 189 mares, for which the diagnosis of UT was confirmed at 3 Dutch equine referral hospitals during 1987–2007. The data available included breed, age and parity of the mare, stage of gestation at which UT was diagnosed and the direction and approximate degree of uterine rotation. The treatment technique, occurrence of post treatment complications (e.g. wound swelling or dehiscence) and post treatment survival of the mare and foal to hospital discharge were available. In addition, informal telephone follow-up was performed, by 2 of the authors (T.J.P.S. and T.A.E.S.), between 12 and 36 months after discharge to ascertain whether the mare had delivered a healthy foal, experienced any further complications and been bred again. If the mare had been bred again, further inquiries were made to determine whether the mare had become pregnant and whether she had experienced any complications during the subsequent gestation.

TABLE 1: Multivariable logistic analysis of factors associated with mare survival following correction of uterine torsion

Stage of gestation	Method	Frequency (n)	Frequency (%)	Survival (%)	Odds ratio	95% Confidence interval	P Wald
<320 days	Standing flank	137	97.2	97.1	33.26	3.69–299.49	0.0018
	Other methods*	4	2.8	50.0	Reference		
≥320 days	Standing flank	25	61.0	76.0	1.44	0.36–5.84	0.6101
	Other methods*	16	39.0	68.8	Reference		

Interaction effect significant (P = 0.0182). Hosmer and Lemeshow goodness-of-fit test (P = 0.99). *n = 20; 1 was treated conservatively, 2 were subjected to euthanasia, 2 had a flank incision under general anaesthesia, 5 had a midline incision under general anaesthesia, and 10 were corrected *per vaginam*.

Data analysis

Exact logistic regression was used to account for small sample sizes and different sized categories of explanatory variables. First, the data set was analysed in terms of factors affecting survival of the mare or foal by univariable logistic regression for the following classification variables: horse breed (Dutch Warmblood vs. other breeds); stage of gestation (<320 vs. ≥320 days); direction of uterine rotation (left vs. right; anticlockwise vs. clockwise); degree of rotation (<360 vs. ≥360°); and correction method employed (SFL vs. other methods). Variables for which P<0.25 were entered into a multivariable regression model, in which a backwards deletion procedure was performed until variables had P<0.05 or were confounders according to the method of Hosmer and Lemeshow [19]. Confounding was considered to be present if deletion changed estimates of other variables by >25%, or >0.1 when the estimates were between -0.4 and 0.4. Confounding was not present in either the mare survival or foal survival models. In the final multivariable model, 2-way interactions were tested and considered statistically significant at P<0.05. Results were expressed as percentages and as odds ratios with their 95% confidence intervals [20].

Results

One hundred and eighty-nine mares were treated for UT. These included 141 mares (77.5%) at <320 days of gestation and 41 (22.9%) at ≥320 days. The estimated degree of rotation was recorded for 127 mares and included 7 (5.5%) recorded as <180°, 85 (66.9%) of 180–360° and 35 (27.6%) of ≥360°. The incidence of more severe torsions appeared to be higher for mares presented relatively late in gestation (>301 days: 19/43, 44.2%) than for those presented at earlier stages (12/80, 15%). Breed was recorded for 186 of the mares treated for UT. The Dutch Warmblood was the most frequently recorded breed (111, 59.7%), while the 75 (40.3%) horses of other breeds consisted of 27 Friesians (14.5%), 12 Arabians, 7 Welsh ponies, 6 draught horses, 3 Haflingers, 3 Fjord horses and 17 others representing 13 additional breeds. The overall breed distribution broadly reflected the general referral case population at the clinics involved. Mean (±s.d.) stage of gestation at diagnosis was 283 (±38) days (n = 186), with a range of 153–369 days. Mean (±s.d.) mare age was 9.1 (±4.7) years (range 2–24), and mare parity ranged from the first to the15th ongoing pregnancy (median = 3). None of the mares had been affected by UT in previous pregnancies. All mares had undergone a single intervention; 169 were treated by SFL, 10 were corrected *per vaginam* in foaling mares, 5 were treated by midline laparotomy under general anaesthesia and 2 by flank laparotomy under general anaesthesia; one mare was treated conservatively (i.e. UT spontaneously resolved); and the final 2 were subjected to euthanasia without attempting correction.

In total, 90.5% (171/189) of the mares and 82.3% (153/186) of the foals survived to hospital discharge, and all of these also survived to foaling.

Univariable analysis (Supplementary Item 1) revealed that correction method, stage of gestation and degree of rotation were significantly associated with both mare and foal survival. Standing flank laparotomy resulted in higher survival of both mares (93.5%; n = 169) and foals (88.0%; n = 166) than other methods combined (respectively, 65 and 35%; n = 20; P = 0.0007 and P<0.0001). Survival of mares and foals was, respectively, 95.7 and 90.6% when UT occurred at <320 days of gestation, compared with 73.2 and 56.1% later in gestation (both P<0.0001). When UT was <360°, mare and foal survival were, respectively, 97.8 and 90.0%, compared with 77.1 (P = 0.0003) and 73.5% (P = 0.03) for more severe rotations. Only 2/18 foals survived UT that resulted in the death of the mare (both involved dystocia and resolution by caesarean section), while 89.9% of foals (151/168) survived when the mare survived (P<0.0001). Clockwise (to the right) and anticlockwise (left) rotations were equally represented in respectively 48.6 and 51.4% of cases. Direction of torsion (clockwise vs. anticlockwise), and horse breed (Dutch Warmblood vs. other) were not associated with differences in mare and foal survival (P>0.4). Survival of mares was not significantly affected by the occurrence of wound complications in the post operative period (P>0.9); of 54 mares without notable complications 94.4% survived, compared with 96.8% survival for 31 mares with post operative wound swelling and/or superficial skin dehiscence. There was no association of the age of the mare at treatment with either mare (P>0.9) or foal survival (P = 0.6).

The multivariable logistic regression analysis included 179 foals and 182 mares. Stage of gestation at occurrence and correction method affected survival after UT correction for both mares (Table 1) and foals (Table 2). For mare survival, an interaction between stage of gestation and correction method was apparent (Table 1). However, techniques other than SFL were used on only 4 out of the 141 (2.8%) mares treated for UT at <320 days, making it difficult to determine whether this apparent effect is clinically relevant. When stage of gestation was ≥320 days, survival after SFL was not significantly better than after correction by other methods (Table 1).

Of those mares presenting at >320 days and treated with SFL, 4 subsequently required a caesarean section and 2 fetotomy (6/25, 24%). The incidence of subsequent severe dystocia was much lower when SFL was performed <320 days (2/137, 1.5%; one fetotomy at Day 305 and one caesarean section at Day 313).

Information about subsequent breeding results was available for 159 mares, of which 147 had been treated by SFL and 12 by other methods. In 36 cases (22.6%), mares were not bred again: 32 (21.8%) after SFL and 4 (33.3%) after other methods. Of the remaining 123 mares, 93.5% were successfully rebred, and the likelihood of successful breeding did not differ between correction methods (P = 0.9): 108/115 (93.9%) after SFL and 7/8 (87.5%) after other methods. Adjustment for the stage of gestation at treatment did not change this (P = 0.6), nor was it a confounder for

TABLE 2: Multivariable logistic analysis of factors associated with foal survival following correction of uterine torsion

Variable	Category	Frequency (n)	Frequency (%)	Survival (%)	Odds ratio	95% Confidence interval	P Wald
Stage of gestation	<320 days	138	77.1	90.6	3.80	1.45–10.15	0.0069
	≥320 days	41	22.9	56.1	Reference		
Correction method	Standing flank	159	88.8	88.7	6.99	2.18–22.42	0.0011
	Other methods*	20	11.1	35.0	Reference		

Interaction effect not significant (P = 0.95). Hosmer and Lemeshow goodness-of-fit test (P = 0.18). *n = 20; 1 was treated conservatively, 2 were subjected to euthanasia, 2 had a flank incision under general anaesthesia, 5 had a midline incision under general anaesthesia, and 10 were corrected *per vaginam*.

correction method. Post operative wound-healing complications were not associated with reduced subsequent fertility (P = 0.4): 91.2% of 34 mares with no significant complications were successfully bred subsequently compared with 100% of 22 mares that had complications.

Discussion

The target population for our study were all mid-late gestation mares with UT in The Netherlands. As UT is a relatively infrequent occurrence in the mid-late gestation mare and data from the 3 largest Dutch equine hospitals were included, selection bias with respect to the choice of correction technique is assumed to be negligible. Mare survival after resolution of UT (90.5%) was higher in this multicentre retrospective study than reported in previous surveys (60–84%) [4,8,18]. One factor contributing to the higher mare survival rate may be the relatively large number of UTs treated by the participating clinics, which have considerable experience in rapid diagnosis and resolution. Another factor may be the very low incidence of concurrent gastrointestinal lesions recorded in the present survey (1/189), which contrasts markedly with the 8/63 (12.6%) of mares with intestinal complications reported by Chaney *et al*. [18]. In further contrast to Chaney *et al*. [18], the method of correction did appear to affect mare survival in the present study. This may be because the majority of mares were treated at <320 days of gestation (77.1%) and the majority of these (97.2%) were treated by SFL. It is also probable that the relative success was biased by the reasons for choosing not to use SFL to correct UT. In all 3 clinics, the decision to use alternative techniques would either be owner preference or, more often, because the mare showed signs of readiness for birth, the torsion was >360°, or SFL was considered inadvisable because, for example, of clinical complications, such as severe colic. The likely reasons for not selecting SFL help to explain why SFL appeared to be more favourable for mare survival than the alternatives. The most obvious additional risk factor for rolling, midline or recumbent flank laparotomy is the need for general anaesthesia compared with standing sedation and local anaesthesia for SFL. The reported peri-operative fatality rate for emergency abdominal operations under general anaesthesia in horses is 11.7% [21]. Beyond 320 days of gestation, SFL no longer had a statistical advantage over other techniques in terms of mare survival.

Foal survival was also higher than reported previously and, confirming previous reports [18], a significantly higher foal survival rate was recorded when the uterine torsion occurred at <320 days of gestation. This is presumably because pressure on the uterine blood vessels in the crossed broad ligaments is less during UT in earlier gestation when the fetus is lighter. As a result, placental perfusion and fetal oxygenation may not be compromised as profoundly as when UT occurs at later stages [22]. In addition, more severe torsions (i.e. >360°) that are more likely to compromise blood flow also appeared to be more common beyond Day 300 of gestation. The haemodynamic consequences of UT during later gestation (>310 days) may be magnified further by the greater fetal requirement for delivery of oxygenated blood through the uterine arteries [23]. Vascular compromise resulting from UT may be further exacerbated by general anaesthesia and dorsal recumbency, which may be additional risk factors for the foal when UT is corrected in the recumbent mare [23].

In general, and in contrast to some other studies [4,18], we consider a uterine rotation of <180° to be within the normal range of fetal movements [24]. Nevertheless, in the present study, 7 cases were recorded as involving rotations of <180°. The fact that one of these less severe rotations resolved spontaneously suggests that this is often a normal variation, and it is questionable whether the other 6 cases in this study or the 42/63 cases of torsions of <180° reported by Chaney *et al*. [18] required intervention. However, the differences between studies may also involve a difference in definition or categorisation; for example, broad ligaments crossing at an angle of ~90° would represent a torsion of somewhere between 180 and 360°. The presence of other gastrointestinal lesions may also be a factor complicating diagnosis, because distension of the colon can lead to elevation of one broad ligament and rotation of the uterus; this may be diagnosed as a uterine rotation of <180° associated with persistent colic leading to surgical intervention, and a midline laparotomy would be the technique of choice for attempting correction because it would allow better investigation of possible gastrointestinal complications.

Univariable analysis showed that with torsion <360°, mare and foal survival were higher than with more severe rotations. This is not unexpected, because rotation of >360° will cause more severe vascular occlusion, with a higher risk of fetal compromise and uterine tissue damage. Severe rotations were also more common in later gestation. The direction of torsion in this study had a roughly equal distribution and did not influence either mare or foal survival. Vandeplassche *et al*. [8] and Chaney *et al*. [18] reported a higher incidence of anticlockwise torsions, whereas Pascoe *et al*. [4] reported more clockwise rotations. Barber [25] suggested that the anatomical difference in the point of attachment of the 2 broad ligaments (right more cranial in the abdomen) favoured an anticlockwise torsion, but this was not evident in the present study.

Other presumed risk factors for UT, such as increasing mare age and parity, were not found in the present study or in the study by Chaney *et al*. [18]. Although the majority of mares treated for UT were Dutch Warmblood horses, this reflects the referral case population distribution at the 3 clinics and thus is not evidence to support suggestions that UT occurs more commonly in draught horse breeds than in lighter horses [1,2]. In our study, horse breed was not associated with mare and foal survival.

This study confirmed previous suggestions that fertility subsequent to treatment for UT was not compromised, and none of the mares had been treated for UT in previous pregnancies. Correction method, stage of gestation at occurrence, degree and direction of torsion or wound-healing complications did not influence subsequent fertility. Potential effects on fertility or risks of recurrence should therefore not influence the decision to use one surgical technique over another, or whether to breed the mare again [4,10,18].

In conclusion, this study suggests that the prognosis for mare and foal survival following correction of UT by SFL prior to Day 320 of gestation is favourable. However, occurrence of UT later in gestation and rotation of >360° are associated with a markedly less positive outcome, particularly for the foal. In our case population, SFL appears to be the treatment of choice for resolving UT except in late gestation (≥320 days). Standing flank laparotomy would not be the most appropriate choice for mares suspected of concurrent gastrointestinal lesions, which were not observed in this study.

Authors' declaration of interests

No competing interests have been declared.

Ethical animal research

Ethical review not currently required by this journal: retrospective analysis of case records. Owner consent for inclusion in the study not stated.

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Authorship

T.J.P. Spoormakers contributed to study design, study execution, data collection and preparation of the manuscript. E.A.M. Graat contributed to data analysis interpretation and preparation of the manuscript. F. ter Braake, T.A.E. Stout and H.J. Bergman contributed to data collection and preparation of the manuscript.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1: Effect of variables on mare and foal survival after correction of uterine torsion (univariable logistic regression) with frequency (n and %), survival%, odds ratios and their 95% confidence intervals and P values (Wald's and -2Log-Likelihood).