Tissue Strength and Collagen Content of the Equine Linea Alba Following Ventral Midline Celiotomy

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In the absence of incisional complications, the equine linea alba regains a tensile strength comparable with a preoperative strength as early as 8 weeks after a ventral midline celiotomy. Repair collagen is mature and formed into organized bundles by 8 weeks postsurgery. This information may provide a basis for decision making regarding when to return horses to exercise following a ventral midline celiotomy. Authors’ address: College of Veterinary Medicine, University of Tennessee, P. O. Box 1071, Knoxville, TN 37901-1071. © 1998 AAEP.

1. Introduction
Equine abdominal surgery utilizing a ventral midline approach is commonly performed. To our knowledge, to date there are no controlled equine linea alba studies that evaluate the normal healing strength of this structure. The purpose of this study was to determine tensile strength and evaluate collagen content of the healing linea alba over a 6-month period.

2. Materials and Methods
Fifteen healthy horses underwent ventral midline celiotomy as part of a concurrent anastomosis study. Linea incisions were closed in a simple interrupted cruciate pattern with #2 lactomer. Subcutaneous tissues were closed in a simple continuous pattern with 2-0 lactomer, and skin was apposed with stainless-steel skin staples. Perioperative care consisted of the administration of flunixin meglumine (0.25 mg/kg IV q 8 h) and ampicillin sodium (22 mg/kg IV q 8 h) for 72 h. Postsurgically, horses were maintained on intravenous fluids for the first 24 h and then were gradually returned to full feed rations over a 5-day period. All horses were housed in box stalls and hand walked 10 min four times a day for the first 4 weeks postoperatively, then turned out in a small paddock for 4 weeks, and then turned out to pasture.

Horses were euthanatized in groups of three at 2, 4, 8, 16, and 24 weeks postoperatively. The linea alba of each horse was harvested, and two 2-cm sections of the sutured linea alba were preserved in formalin for histologic examination. Lineae albae were stored in saline-soaked towels at -20°C until biomechanical testing was performed. Tensile strength testing was performed by using a materials testing system and cryoclamps to prevent fascial slippage. Each linea was thawed and cut into 2.5-cm-wide strips perpendicular to the incision. Two strips were taken from each of the cranial, middle,
and caudal sections of the incision. The strips were placed into the testing apparatus with the clamps 3.3 cm on either side of the linea alba. The tissue was distracted at a rate of 1 in. (2.54 cm)/min until full thickness breakage occurred. Control values were determined in three nonincised linea alba from three horses euthanized for reasons other than abdominal disease. Histologic samples were stained with hematoxylin and eosin, as well as Mason's trichrome, and they were evaluated by a pathologist for collagen content and maturity.

3. Results
The control group had an average fail point of 484.9 ± 58.3 N (newtons). This was significantly (p ≤ 0.05) stronger than either the 2-week group (average fail point 87.7 ± 61.4 N) or the 4-week group (average fail point 305.8 ± 61.7 N). The 8- and 16-week groups were not significantly different from the control group, with average fail points of 465.4 ± 56.5 N and 477.8 ± 57.2 N, respectively. The 24-week group was significantly (p ≤ 0.05) stronger than the control group, with an average fail point of 721.0 ± 57.9 N. The histologic evaluation indicated that the control samples were characterized by dense mature collagen bundles. Samples from the 2-week group were made up of granulation tissue and a few pre-existing mature collagen fibers. The 4-week samples had fairly abundant immature collagen that was not formed into bundles. In all of the samples from the 8-, 16-, and 24-week groups, there were abundant bundles of mature collagen.

4. Discussion
The lineae albae in this study were progressively stronger over the 24-week study period. This strength was directly proportional to the maturation of the repair collagen present. The evaluation of collagen content was qualitative only. Further study utilizing different staining techniques is necessary for a quantitative evaluation of collagen content.

Surgeons can greatly influence the postoperative healing of an incision, depending on their choice of suture material, bite size, and suture pattern. Perioperative complications such as previous abdominal surgery, incisional infection, postoperative leukopenia, and postoperative pain are all associated with an increased risk for development of incisional hernias. The strength of the healing linea alba will be compromised if any of these complications are present. Strain on the linea alba is increased during anesthetic recovery, rectal palpation, and when the patient trots. Reducing those factors that increase linea alba strain will reduce the risk of incisional dehiscence.

The use of cadaver tissues in this study should not limit its applicability. Connective tissues will maintain their biomechanical properties in vitro if they are properly hydrated and frozen to prevent autolysis. All of these tissues were harvested from previously healthy animals. The presence of concurrent disease or metabolic compromise may affect wound healing and should be taken into consideration.

5. Conclusions
Based on our observations of collagen maturation in the 8-week group and tensile strength being comparable with controls at 8 weeks postoperatively, it would appear that there is a valid scientific argument for returning horses to controlled exercise at 60 days postoperatively. This decision must be guided by careful evaluation of the entire patient, including age, temperament, type of use, and any postoperative complications that might compromise incisional strength. This information would be most useful in those cases in which an early return to athletic use or breeding activity is desired.

References and Footnotes

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