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Palmar annular ligament desmotomy in horses with the Arthrex-Centerline™ : An *ex-vivo* study

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Abstract
The aim of this study was to evaluate the use of a single-portal endoscopic desmotomy of the PAL with the use of Arthrex - Centerline™. Ten horse distal front limbs from horses free of PAL disease were prepared for tenoscopy of the digital flexor tendon sheath (DFTS). A dual-port endoscopic desmotomy with a hook knife was performed in 5 specimens (Group A) and single port Arthrex-Centerline™ Desmotomy was performed in another 5 specimens (Group B). The performing time, judgments of the surgeon, number of blade passages, and gross anatomy were evaluated. The performing time and surgeon judgments were significantly lower in Group B. No significant differences were assessed in number of passages to achieve a complete PAL resection and a gross anatomy evaluation. The use of Arthrex-Centerline™ is feasible for a PAL desmotomy procedure. It was faster with more handling ease compared with the free-hand double-portal desmotomy and allowed the same results in terms of number of passages to complete the release evaluated at gross anatomy.
Keywords: Horse, PAL desmotomy, Tenoscopy.

Introduction

The desmopathy of the palmar annular ligament (PAL) has been described in several different conditions in the horse (Gerring and Webbon, 1984; Dik *et al*., 1995; van den Berg *et al*., 1995; Wilderjans *et al*., 2003). The PAL syndrome is characterized by constriction and thickening of the flexor sheath with a relatively normal appearance of the PAL. This results in a reduction of the movement of the flexor tendons within the caruncle of the fetlock. An increase in the volume of the digital flexor tendon sheath (DFTS) may be due to a lesion within the superficial flexor tendon, the manica flexoria or tenosynovitis of the synovial sheath of the flexor tendons (Dik *et al*., 1995; van den Berg *et al*., 1995; Smith and Wright, 2006).

The classic presentation of the disease is characterized by lameness associated with the fetlock bowed at the level of PAL (Gerring and Webbon, 1984; Smith and Wright, 2006) and the proximal edge of the DFTS. Injury to the PAL has been described in the literature as plantar/palmar annular desmitis (PADs) and is due to a thickening of the annular ligament (McGhee *et al*., 2005).

The PAL desmotomy has been described with several techniques, such as surgical treatment for PAL syndrome. Open surgery, minimally blinded surgery and endoscopic surgery have been employed (Nixon, 1990; Nixon *et al*., 1993; Fortier *et al*., 1999; Hawkins and Moulton, 2002; Smith and Wright, 2006). The use of endoscopic techniques are minimally invasive and allow access to the PAL, creating intraoperative visualization of the intrathechal structures. Different endoscopic approaches were previously described with the use of two portals and several cutting techniques with a standard or angled surgical blade or a hook knife, but these techniques are not completely safe because of potential damage to the surrounding soft tissues and vascular bundle structures. Recently, a slotted cannula technique has been described that prevents accidental damage by using instruments derived from the carpal tunnel release in human medicine. These techniques provide proper PAL release with the use of a dual-port approach (Hawkins and Moulton, 2002).

Recently, a novel instrumentation for a single-portal carpal tunnel release for humans has been commercialized from Arthrex under the name Centerline™. It consists of an arthroscope based instrumentation that is directly inserted into a transparent plastic sleeve and contains a retractile angled blade that is used with a single port access.

The aim of this study was to evaluate the distal portions of *ex-vivo* equine limbs using the Arthrex-Centerline™ for the release of the PAL using a single port.

Materials and Methods

Instrumentation

The Arthrex-Centerline™ tool consists of a kit that includes a scope with a diameter of 2.9 mm that is 158 mm long with a 30° reverse-angle view, two tissue retractors and a disposable sleeve with a scalpel blade and retractable hook (Fig. 1).

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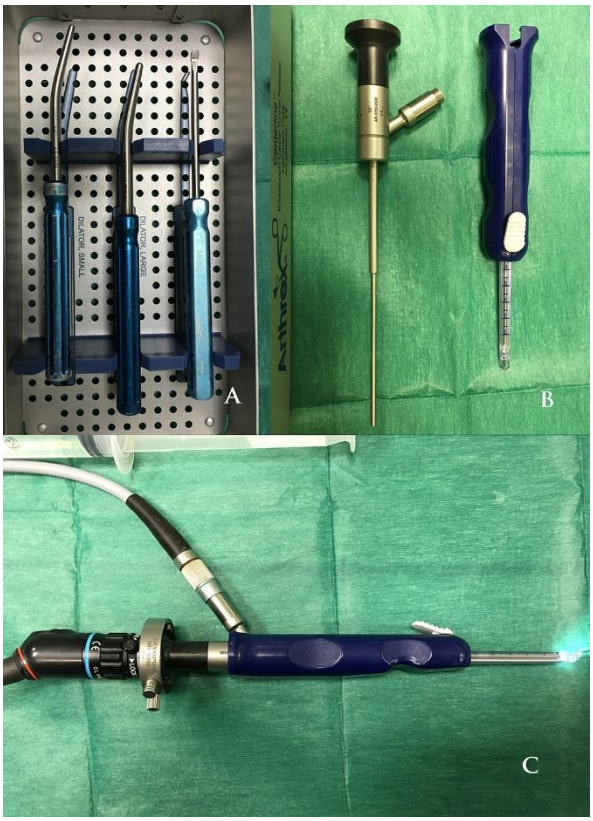

Fig. 1. Arthrex - Centerline™ Instruments kit. **(A):** set of tissue divaricator. **(B):** 2.9 mm x 158 mm, 30° reverse optic disposable sleeve. **(C):** Instrument assembled.

Study design

The study was performed using *ex-vivo* specimens of distal limbs from regularly slaughtered horses. Ten horse distal limbs from horses free of PAL disease were prepared for tenoscopy of the digital flexor tendon sheath (DFTS).

Five of these specimens were randomly assigned to Group A, in which a tenoscopic approach with a dual port was performed as previously described (Nixon *et al*., 1993).

The optical port was open on the side of the distal portion of the digital flexor tendon sheath with a view of 30° and a 4.0-mm diameter. Continuous distension of the DFTS has been achieved with an arthroscopy pump with a pressure of 100 mmHg and a flow rate of 40 ml/min. After exploring the tendon sheath and identifying the annular ligament, a portal was created with the instrument in the proximal portion of the tendon sheath as described (Nixon *et al*., 1993). For desmotomy of the PAL, a hook knife was used.

The other five specimens were assigned to Group B, in which a single-access portal for desmotomy of PAL using the Arthrex-Centerline™ was used. After expanding the tendon sheath with 50-60 ml of Lactated Ringer's Solution, the procedure was executed using the portal at the recess of the distal palmar DFTS between the PAL and digital annular ligament. A 21-g needle was inserted into the proximal edge of the PAL, and once the proximal limit of the PAL was isolated, a retractor from the kit was placed; following the completion of our study, the company inserted the retractor into the optical system of the Arthrex-Centerline™ through the same portal (Fig. 2).

Once the DFTS was explored and anatomical structures were located, the instrument was positioned on the palmar side on the proximal edge of the PAL, and the blade was used to perform the release of the ligament until the subcutaneous connective was visualized (Fig. 3.).

Both techniques were performed by the same surgeon.

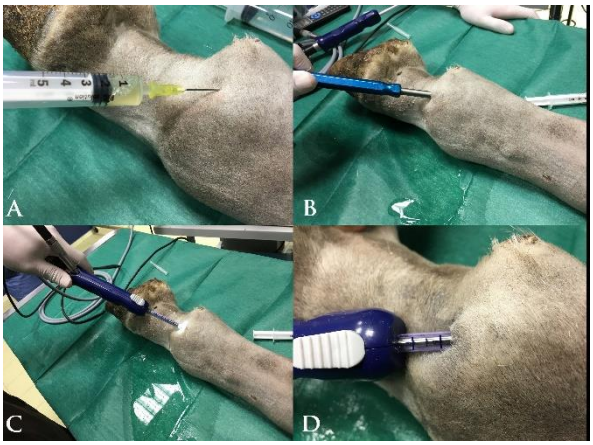

Fig. 2. Images of surgical procedure. **(A):** Distension of Digital Flexor Tendon Sheath with 60 ml of ringer lactate. **(B):** After stab incision in the collateral recess of DFTS, a tissue divaricator was inserted to facilitate the sleeve entrance. **(C):** Insertion of assembled sleeve and optic. **(D):** Full insertion of the Arthrex - Centerline™.

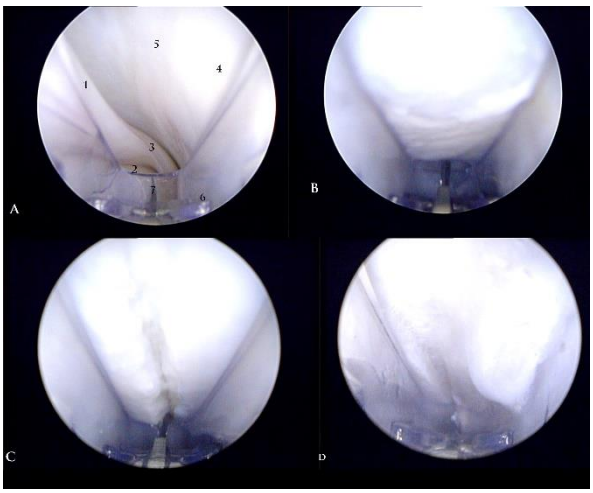

Fig. 3. Tenoscopic view. **(A):** DFTS inspection (1 SDFT; 2 DDFT; 3 manicaflexoria; 4 PSB; 5 PAL; 6 sleeve; 7 blade in safe position). **(B):** blade activated. **(C):** PAL after the passage of the blade. **(D):** completed release of PAL and subcutaneous tissue.

For each sample, we evaluated the following criteria:
- Surgery Time (minutes);
- Number of passages for the execution of the complete resection;
- Judgment of the surgeon (3-difficult, 2-medium difficulty, 1-easy to perform); and
- Assessment of the release during gross anatomy evaluation (3-full, 2-partial, 1-insufficient).

Statistical analysis

The parametric and non-parametric data were assessed by 13.1 MedCalc software. The parametric data between groups were evaluated by an ANOVA test, while non-parametric data were compared using the Wilcoxon test. The significance was set at $p < 0.05$.

Results

The study results, reported in Table 1, with number of steps necessary for the complete resection of the ligament, evaluated during the surgery and the anatomical dissection, showed no significant differences. Statistically significant differences were found comparing the times of use of the Arthrex-Centerline™ (16.6 min) and the technique using two ports (21 min). Moreover, the overall opinion expressed by the surgeon demonstrated a better appreciation for the use of the single-port technique. In this study, the use of Arthrex-Centerline™ proved to be an easy application for a PAL desmotomy. The instrumentation was easy to handle and assemble. The use of the supplied instrumentation allows for a minimally invasive surgery due to the necessity of a single portal and does not need continuous distension of the synovial sheath through the use of infusion pumps. In fact, the distension of the sheath is only necessary for the identification of the PAL landmarks before the introduction of the instrument and not during the visual and endoscopic resection, unlike the technique using two access portals.

Table 1. The table shows results compared between the groups; Group A double-port free-hand technique, Group B single-port Arthrex - Centerline™.

Specimen	Surgery time (min)		Number of Passages		Judgment of surgeon		Gross Anatomy Evaluation	
Group	A	B	A	B	A	B	A	B
1	20	16	1	1	2	1	3	1
2	22	18	2	2	3	2	2	2
3	16	15	1	1	2	1	3	1
4	23	19	1	2	2	1	3	1
5	28	15	3	2	2	2	2	2
Mean	21.8	16.6*	1.6	1.6	2	1*	3	1*
Median	22	16	1	2	2	1	3	1
SD	4.38	1.82	0.89	0.55	0.45	0.55	0.55	0.55

Surgery time (minutes); Number of steps for the execution of the complete PAL release; Judgment of the surgeon (3: difficult; 2: medium difficulty; 1: easy to perform); Assessment of the release at gross anatomy (3: full; 2: partial; 1: insufficient). *statistically different ($p<0.05$).

Discussion

The study showed that the Arthrex-Centerline™ can be used for release of the palmar annular ligament in horses, providing some advantages over the technique using two portals as well as free-hand resection described in the literature. We analyzed these two techniques in a comparative manner in this study.

The first report concerning a desmotomy of the PAL described an open approach (Adams, 1974). With this technique, the skin and the subcutaneous tissue are incised and then the annular ligament is released, resulting in a long incision on the palmar/plantar surface of the fetlock, also described more recently (Chan *et al*., 2000). Another previously described procedure for the PAL desmotomy consisted of a blind approach where a curved scalpel or a Mayo scissors is inserted below the PAL and above the tendon sheath. The PAL is cut throughout its length, taking care to perform a complete desmotomy. The first disadvantage is having to blindly perform the technique. The second is that the free-hand dissection involves a subjective evaluation of the PAL desmotomy. With the blind technique, the surgeon cannot be sure whether the manica flexoria has been accidentally incised during surgery.

The tenoscopy definitely offers the advantage of better visualization within the operative field, a better diagnosis and a reduction in both the surgical wound and risks of complications (Nixon *et al*., 1993; Barr *et al*., 1995; Dik *et al*., 1995; Wright and McMahon, 1999). Since the advent of tenoscopy, reported cases of tendon fistulas and post-operative infections compared to those reported in the use of the open technique are definitely less frequent (Gerring and Webbon, 1984; Wright and McMahon, 1999).

Another method of the PAL desmotomy consists of the use of a slotted cannula and a scalpel blade rotated 90° (Nixon *et al*., 1993). The advantage of using a slotted cannula includes full control with visualization of the PAL during resection.

In our study using the Arthrex-Centerline™, the release of the PAL is similar to the technique already described in the literature but is executable with less time and with greater ease by the surgeon.

The technique with two portals, in fact, showed a longer learning curve and a more complicated performance than the triangulation technique used with the single-port Centerline™. In addition, it was noted that with the use of Centerline™, the endoscopic visualization is excellent and does not need a continuous distension of the tendon sheath, thus improving the maneuverability of the instrument while avoiding the use of an arthroscopic infusion pump, which is necessary during the two-portal access technique.

Compared to other surgical techniques described in the literature (Nixon, 1990; Hawkins and Moulton, 2002),

as in the technique of "slotted cannula", the Arthrex-Centerline™ retains the advantage of a single port, further reducing the limitations of a minimally invasive surgical technique and resulting trauma to the synovial sheath. Furthermore, in the technique described when the cannula is used, it is constructed of metal, which reduces the side view in comparison with the Centerline™.

The Centerline™ is composed of a transparent plastic material and expands the field of vision, thus avoiding incidental trauma to other structures, such as the manica flexoria or within the same flexor tendons.

Regarding the quality of resection, in this study, both techniques were proven successful in executing the PAL resection in a comprehensive and effective way using the same number of steps required for the implementation of a complete resection. However, the technique using the two-portal access with a hook knife requires greater surgical skill, as the triangulation in this technique is difficult for the position of the instrument in opposition to the optics and for the overall dimensions of the two instruments. Therefore, for the same number of steps required to perform a complete resection, the Arthrex-Centerline™ handling technique is easier and does not require triangulation, so the surgeon needs less time. The overall rating of this technique by the surgeon who performed it is more favorable with the use of the Arthrex-Centerline™, resulting in a more manageable, less cumbersome, faster and easier resection.

Although several advantages of the Arthrex-Centerline™ have been highlighted in this study, there are some limitations of the instrument. This endoscopic instrumentation is dedicated exclusively for use with the Centerline™ cannula and therefore cannot be used for other diagnostic or surgical endoscopic procedures. Furthermore, the optical instrumentation has a high cost and amortization over time, thus increasing the required number of procedures.

However, the cannulas are disposable, and using a sharp knife that loses its thread quickly makes their use very limited while using low-temperature sterilization techniques. The disadvantages of either the cannulas or the sharp knifes discussed do not apply to the plastic structure of the instrument.

Therefore, although this instrument is absolutely feasible for the of the release of the PAL, it requires further studies *in-vivo* that would give rise to a greater number of directions in order to justify the acquisition costs of the instrument.

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Arthrex GmbH, Erwin-Hielscher-Str. 9, D-81249 Munich, Germany. The paper was edited by Wiley Editing Services.

Conflict of interest

The authors declare that there is no conflict of interests.

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