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Hypothesis Article

Hypothesis on the pathophysiology of small intestinal strangulation by a pedunculated lipoma

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Summary

The current hypothesis proposed for strangulation of small intestine by a pedunculated lipoma in horses involves movement of the lipoma around the small intestine until it loops through its own pedicle. This mechanism is difficult to demonstrate during surgical correction. The objective was to examine an alternative explanation for strangulation by pedunculated lipomas that is logical and consistent with intraoperative findings by the analysis of the anatomical features of 11 cases of lipoma strangulation in horses. In the proposed hypothesis, the stalk of the lipoma is tensed by the weight of the lipoma alone or by external forces on it from adjacent intestine. This produces a slit-like aperture formed by the stalk and the contiguous mesentery. One or more loops of intestine pass across the lateral edge of the stalk before turning into this aperture, either because of lack of space in the abdominal cavity or through the effects of peristalsis. The weight of the intestine itself causes the loop to 'fall' into the aperture and become entrapped. This creates a half-hitch knot in which the loop of intestine uses the lipoma pedicle as a 'post' around which it becomes strangulated. It was concluded that the proposed hypothesis differs from the existing one by requiring intestinal movement to create the strangulation, which is more plausible than the current proposal that the strangulation is caused by movement of the lipoma itself. It is also more consistent with surgical findings.

In horses, small intestinal strangulation by a pedunculated lipoma is a common cause of obstruction, representing 3%–7% of all colic cases and 7%–13% of all horses undergoing exploratory laparotomy for investigation of colic signs (Archer 2017). The pathogenesis of pedunculated lipoma strangulation has been attributed to movement of the lipoma around a loop of intestine, wrapping it with its stalk (Edwards and Proudman 1994) to form a 'bola' (from Spanish, meaning 'ball', a type of throwing weapon made of weights on the ends of cords, used to capture animals by entangling their legs). Spontaneous movement of the lipoma around the loops of intestine to become entangled as described is unclear (Edwards and Proudman 1994; Kilcoyne and Nieto 2020). Also, if the lipoma were to move around the long segments of intestine and mesentery, as seen in many clinical cases, the pedicle would be too short to allow enough room for the lipoma to pass under it, as is typically illustrated. Furthermore, it is not clear why some lipomas tend to lie dormant and others lead to intestinal strangulation (Kilcoyne and Nieto 2020). A lipoma originates from plaques of fat between the two serosal layers of the mesentery. As it grows, its weight stretches the serosa to form a pedicle that attaches it to the mesentery. In the study by Edwards and Proudman (1994), the authors found that strangulating lesions were significantly associated with the weight of the lipoma. They found that lipomas causing strangulating lesions were in the range of 33–688 g, while those causing nonstrangulating lesions ranged from 3 to 259 g. These findings led the authors to state that 'Any lipoma heavier than 33 g has the potential to cause intestinal obstruction' (Edwards and Proudman 1994). The length of the stalk or pedicle of a lipoma could also play a role in the pathogenesis of strangulation (Kopf 1985) because generally strangulating lesions are caused by lipomas with a long pedicle. Nonstrangulating lesions are caused by lipomas with a pedicle that originates close to the junction between mesentery and intestine in most cases (Edwards and Proudman 1994). There are some cases, where a short-stalked lipoma can cause strangulation of a loop of intestine (Edwards and Proudman 1994) (**Fig 1**). The length of the intestine that becomes entrapped by the lipoma can vary considerably, and many loops of intestine can be entrapped by one pedunculated lipoma. This is difficult to explain with the existing 'bola' model. Strangulation by lipoma can take several forms, including strangulation by omental lipoma or mesenteric lipoma, strangulation of small intestinal mesentery only, strangulation of multiple loops or loops of variable lengths, and involvement of lipomas of variable size. The mechanism hypothesised in this report could be compatible with all these different forms. The anatomopathological features of cases of pedunculated lipoma in horses submitted to colic surgery provided the basis to the proposed hypothesis to explain how a lipoma can strangulate the small intestine. In one clinical case, our hypothesis was supported by finding that the lipoma strangulation could be corrected by reversing the mechanism proposed for movement of the intestine relative to the lipoma pedicle (**Figs 1-7**). Furthermore, in several other cases, we found that the stalk of the lipoma was of such a length that the lipoma extended ventral to the length of the mesentery and intestine combined at that location. We hypothesise that the stalk is kept under tension by the weight of the lipoma or by ventral traction on it exerted by surrounding intestinal loops. The tension on the stalk produces a slit-like aperture or narrow gap

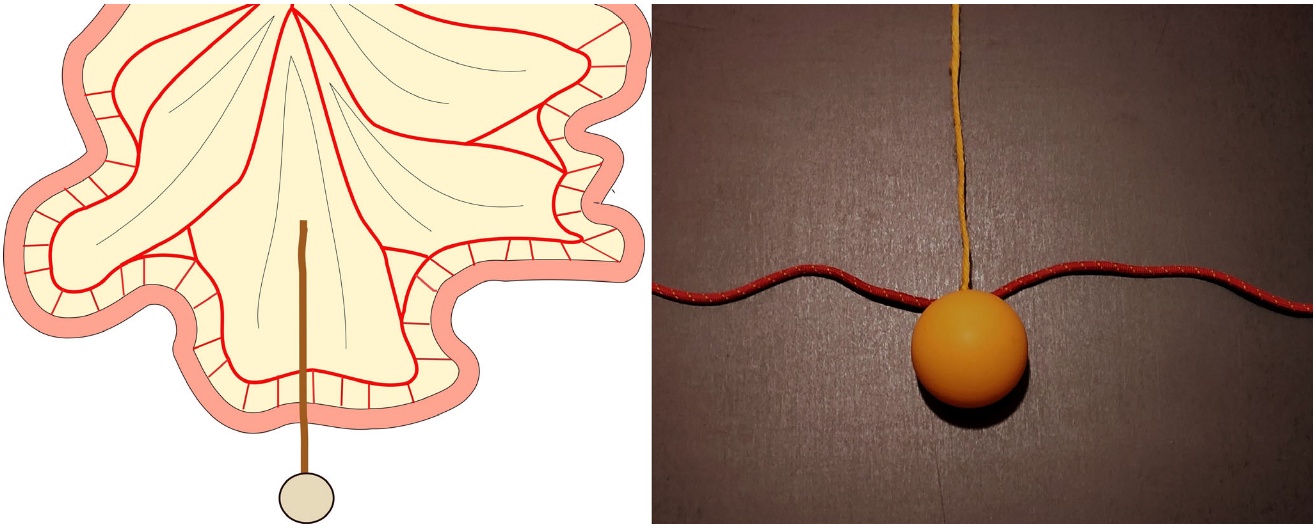

***Fig 1:** Lipoma suspended across the mesentery.*

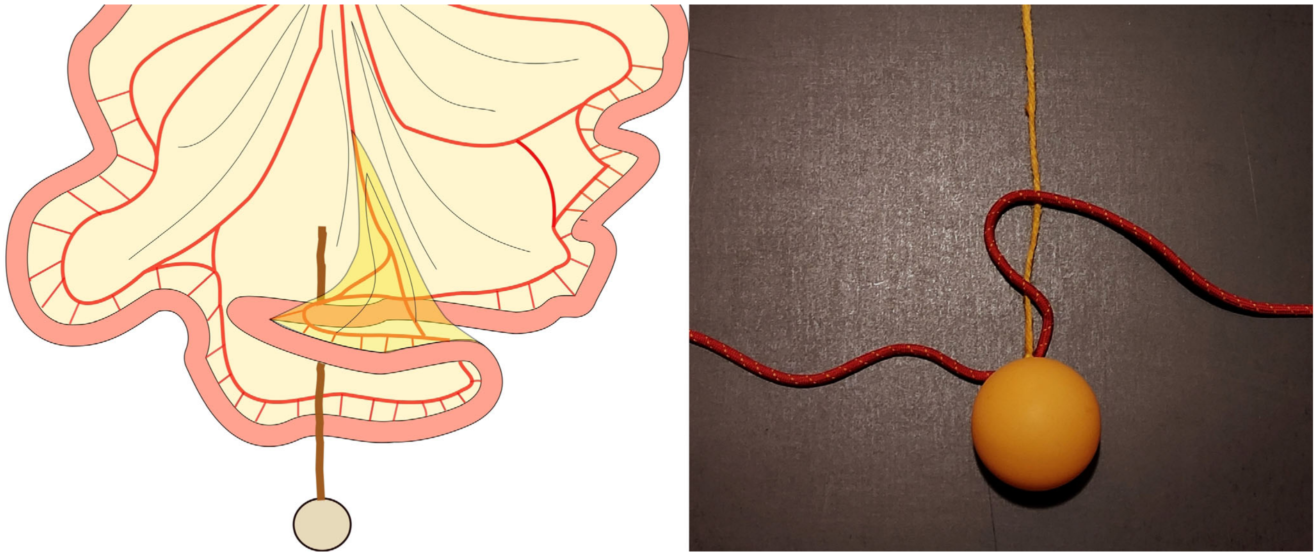

***Fig 2:** The intestine moves across the stalk.*

between the stalk itself and the adjacent, usually contiguous mesentery, or the small intestine (**Fig 1**). The position of the lipoma relative to the intestine may also play a role. If the stalk is of such a length that the lipoma lies ventral to the small intestine, a larger slit-like aperture is created that could accommodate long segments of small intestine. At this point, one or more loops of intestine that are initially found lateral to the stalk (**Fig 2**) can turn into this aperture under the influence of peristalsis or to occupy the available space created (**Fig 3**). Peristaltic waves then travel from proximal to distal when this loop becomes obstructed by the mesentery and the lipoma stalk. As the entrapped loop fills with fluid, it draws progressively more intestine into the gap between pedicle and mesentery (Kopf 1985). The peristalsis of the proximal portion of intestine that entered the slit opening will pull the loop out of the incarceration. In addition to fluid distension, peristalsis of the distal portion will pull the intestine into the opening. The increased weight of the segments that enter the opening acts to overcome the effect of peristalsis in drawing intestine out of the incarceration. The balance between distension drawing intestine into the entrapment and peristalsis pulling intestine out of it could determinate the length entrapped, eventually reaching a point at which the degree of entrapment is complete. These forces lead to the involvement of a length of entrapped intestine that can be a few centimetres to several metres by the time peristalsis ceases and distension reaches its limit. This mechanism can also explain how strangulation by lipomas of the distal jejunum often involves the ileum (Kopf 1985). These mechanisms have been proposed by Kopf for inguinal hernia incarceration, but may also apply to lipoma strangulation. At this stage, the weight of the intestine that passes into the opening will cause it to 'fall' through the loop, thereby 'cinching' the incarceration (**Fig 4**). In fact, until occlusion of the lumen is complete, the peristaltic wave

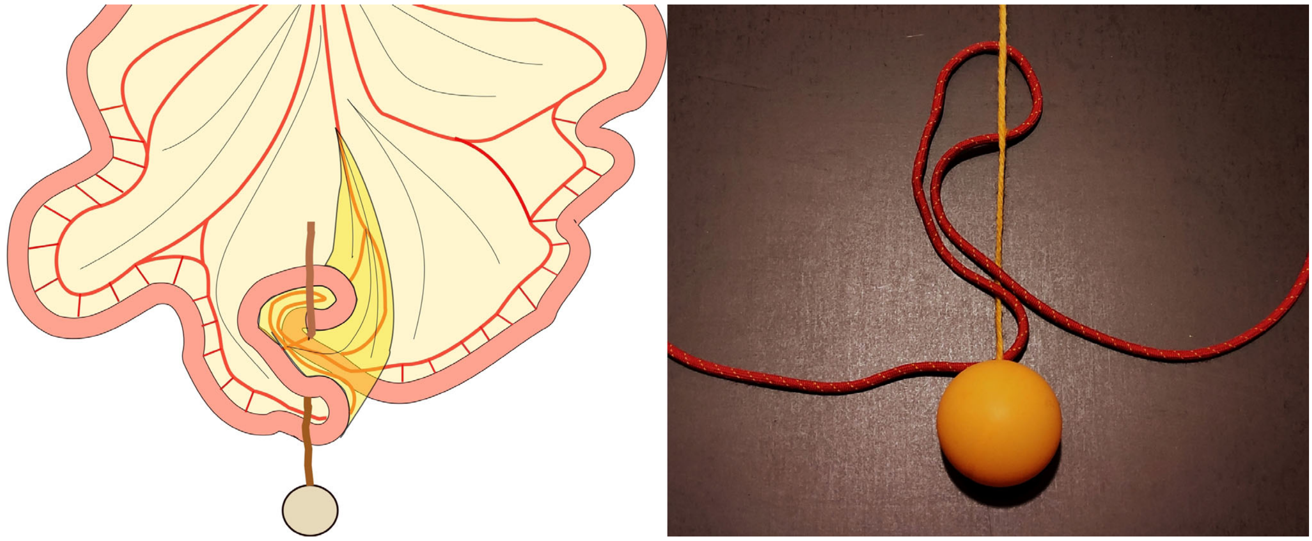

***Fig 3:** Because of the peristalsis or lack of space in the abdominal cavity, the intestine enters the split-like opening.*

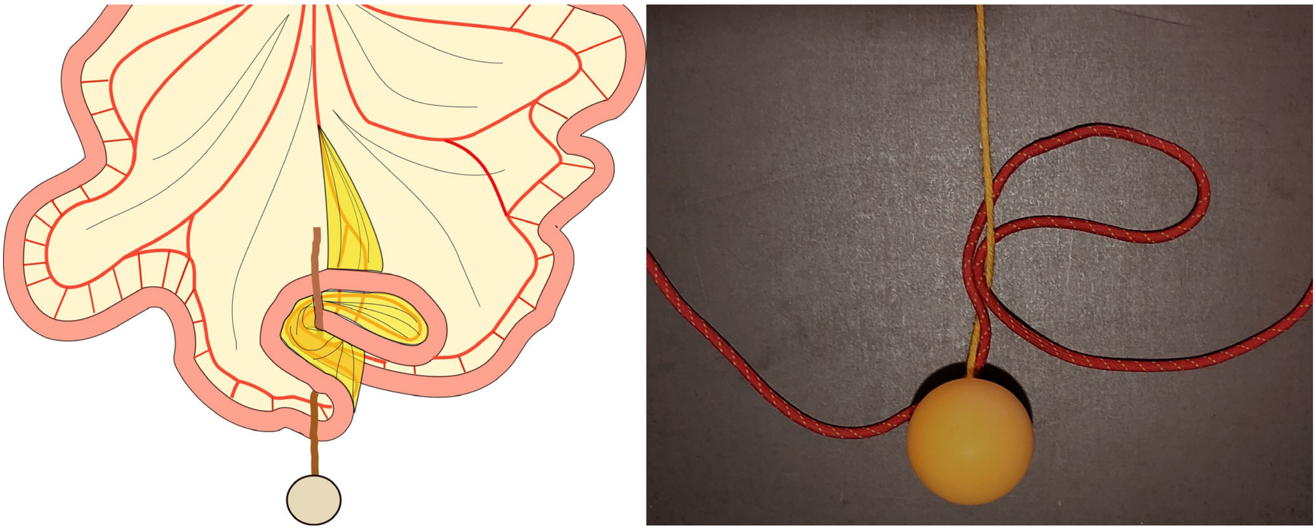

***Fig 4:** Because of the effects of distension and peristalsis, more intestine is drawn into the opening*

forces contents into the incarcerated segment, thereby increasing its weight and ultimately causing the strangulation. Peristalsis of the distal segment can, by that point, reach a limit and cease to contribute to further incarceration of bowel. The tightness of the incarceration is determined by the lipoma becoming entrapped within a distended intestinal segment compressed by the stalk so that it forms two points of distension too close to each other to allow the lipoma to retract from between them. The weight and the distension of the entrapped loop influences the system by causing the 'post' formed by the stalk of the lipoma to turn in a half-hitch that strangulates the loop of intestine (**Figs 5 and 6**), thus causing the lipoma to wrap on its own stalk and making the reverse process impossible (**Fig 7**). At this stage, the intestine starts to undergo ischaemic changes (**Supplementary Item 1**). In the same manner in which one loop of intestine can enter the aperture and become strangulated, so can a second loop of intestine, thus explaining the incarceration of multiple loops by a single lipoma stalk. The above hypothesis can also explain why lipomas of different size and weight can entrap the intestine. In fact, both cases produce strangulation because, in our opinion, they are less likely to produce a fixed post. In our hypothetic model, the relative length of the stalk is more critical than the weight of the lipoma to produce the strangulation. When the stalk is of such a length that it allows the formation of a long aperture, the possibility of the intestine becoming securely entrapped increases. If the stalk originates close to the intestine but is of such a length to allow the lipoma to be blocked underneath the small intestine, it may produce a small but sufficient opening into which the intestine can migrate (**Fig 8a,b**). In his article, Edwards considered this type of presentation peculiar of nonstrangulating pedunculated lipomas (**Fig 9a**)

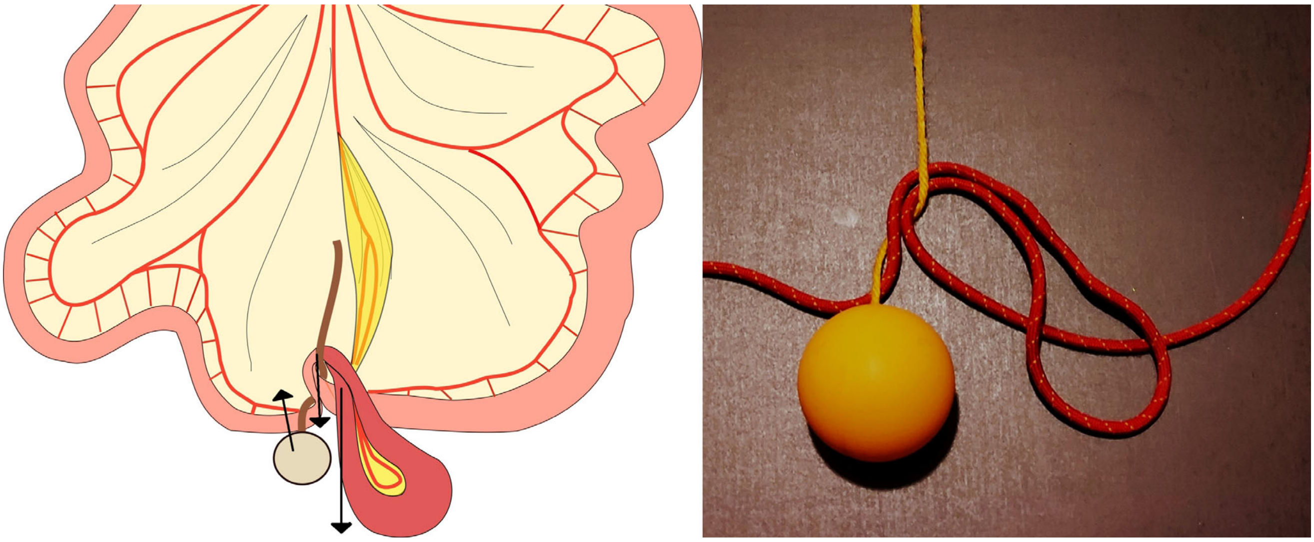

***Fig 5:** The weight of the intestine causes the loop to 'fall'.*

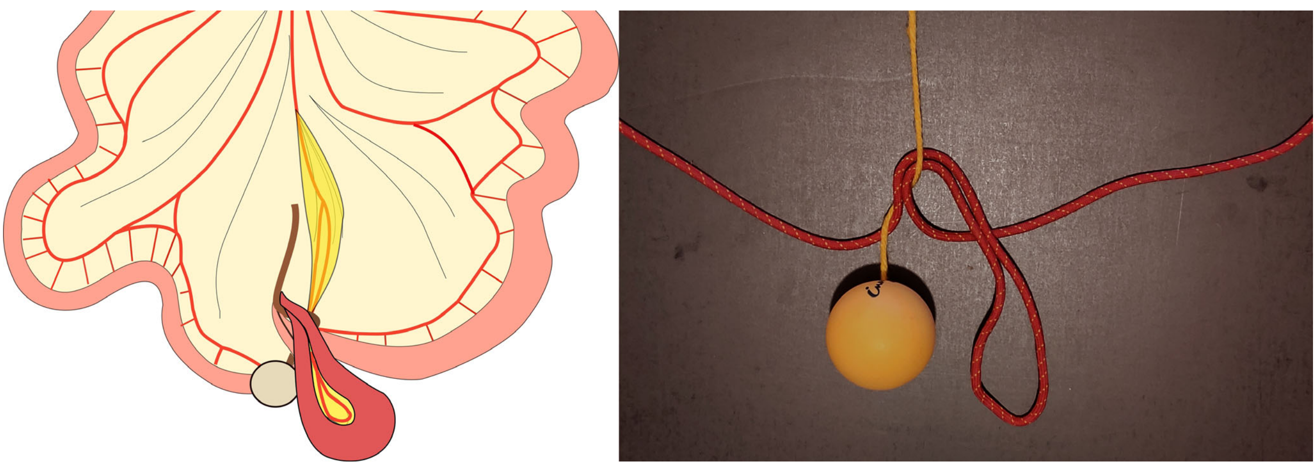

***Fig 6:** A half-hitch knot is formed and strangulation starts.*

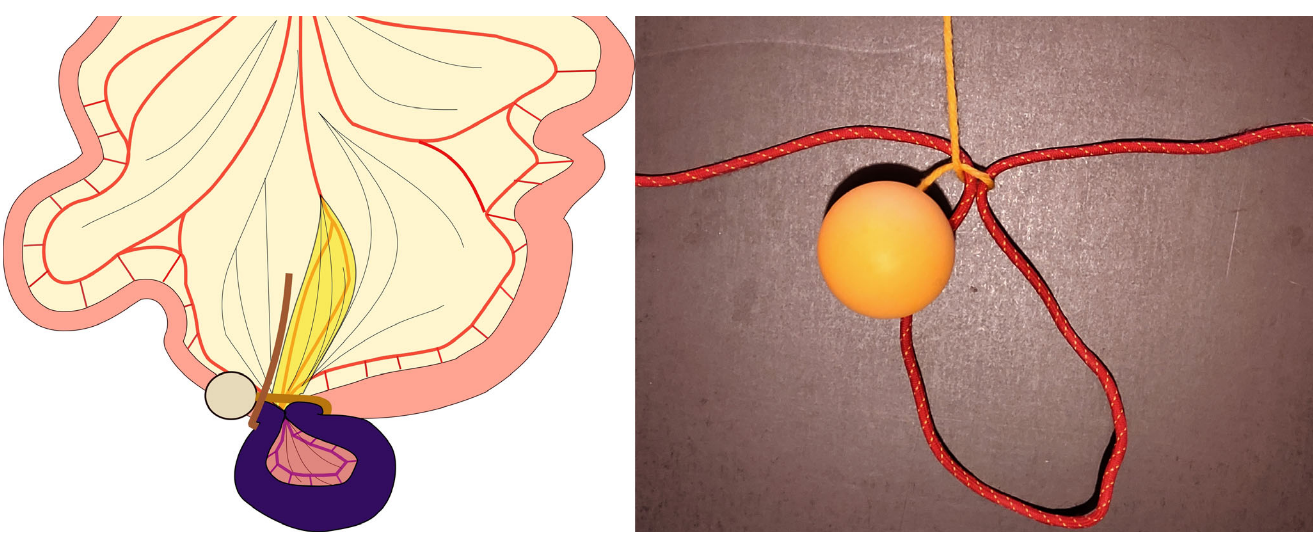

***Fig 7:** With the increase in volume of the strangulated loop, the knot became irreversible.*

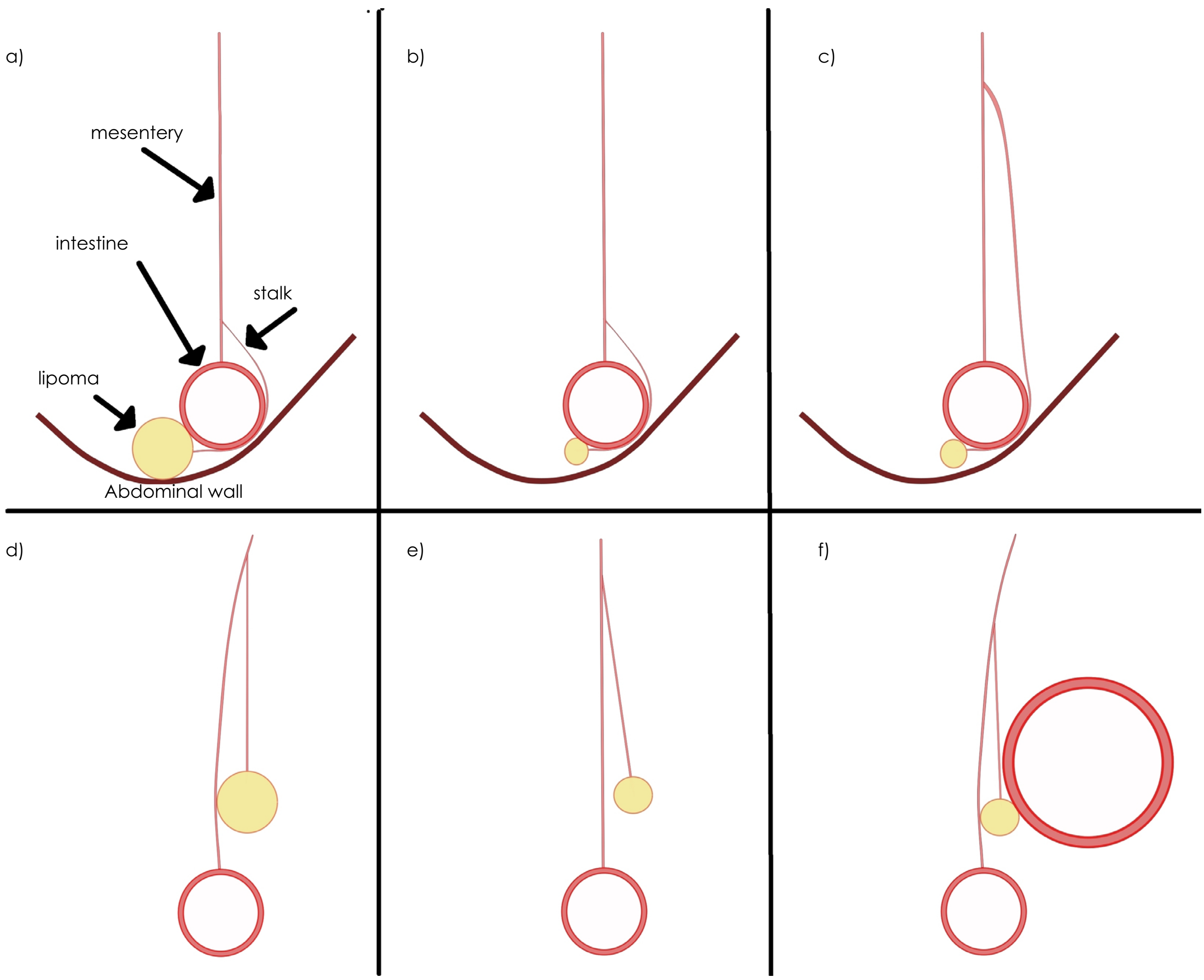

***Fig 8:** Diagrams of the different hypothesis for 'dormant' and pathologic lipomas. a) Large lipoma with stalk originating close to the mesentery–intestine junction; b) small lipoma with stalk originating close to mesentery–intestine junction: its weight is not sufficient to keep the stalk under tension, but this is obtained by the fact that the lipoma is clinched between the intestine and the abdominal wall or other viscera; c) small lipoma with stalk originating in the proximal mesentery: the stalk is of sufficient length to originate the same condition as in 'b'; d) large lipoma with stalk originating in the proximal mesentery: the weight and size of the lipoma are sufficient to put the stalk under tension; e) small lipoma with stalk originating in the proximal mesentery: the weight of the lipoma is not sufficient to put the stalk under tension; f) small lipoma with stalk originating in the proximal mesentery clinched by surrounding viscera: as in 'e', the weight of the lipoma is not sufficient to put the stalk under tension but this may be action of surrounding viscera.*

but short-stalked lipomas can cause strangulation, and this can be only explained by assuming the intestine moves around the stalk. Large lipomas with a short stalk (**Fig 9b**) can also produce mild, recurrent colic by stretching the mesentery, as also reported by others (Downes *et al*. 1994; Verwilghen *et al*. 2013). The above hypothesis can also explain why small lipomas can entrap the intestine. In such cases, the weight of the lipoma may not be sufficient to tense the stalk, but the length of the stalk canpredispose to the entrapment (**Fig 8c**). In the same way, this hypothesis could also explain why some lipomas tend to lie dormant and some lead to severe intestinal damage. Either (in some cases both) the weight of the lipoma or length of the stalk is responsible for the tension on the stalk itself. Small lipomas with a long stalk and heavy lipomas with a relatively shorter stalk are those most likely to cause strangulation (**Fig 8c,d**). Relatively small lipomas with a relatively short stalk are less likely to produce enough tension on the stalk to allow the movement of the intestine. In such cases, the lipoma and its stalk are likely pushed aside from the intestinal movement (**Fig 8e**) unless clinched by another viscus (**Fig 8f**). Our model can also explain the incarceration of intestine without strangulation (Blikslager *et al*. 1992). These cases are rare and can be explained by insufficient time or the optimal conditions (length of the stalk, weight of the lipoma, intestinal content and weight of the entrapped loop) to reach completion. The model we hypothesised can also explain strangulation caused by omental lipomas, in which

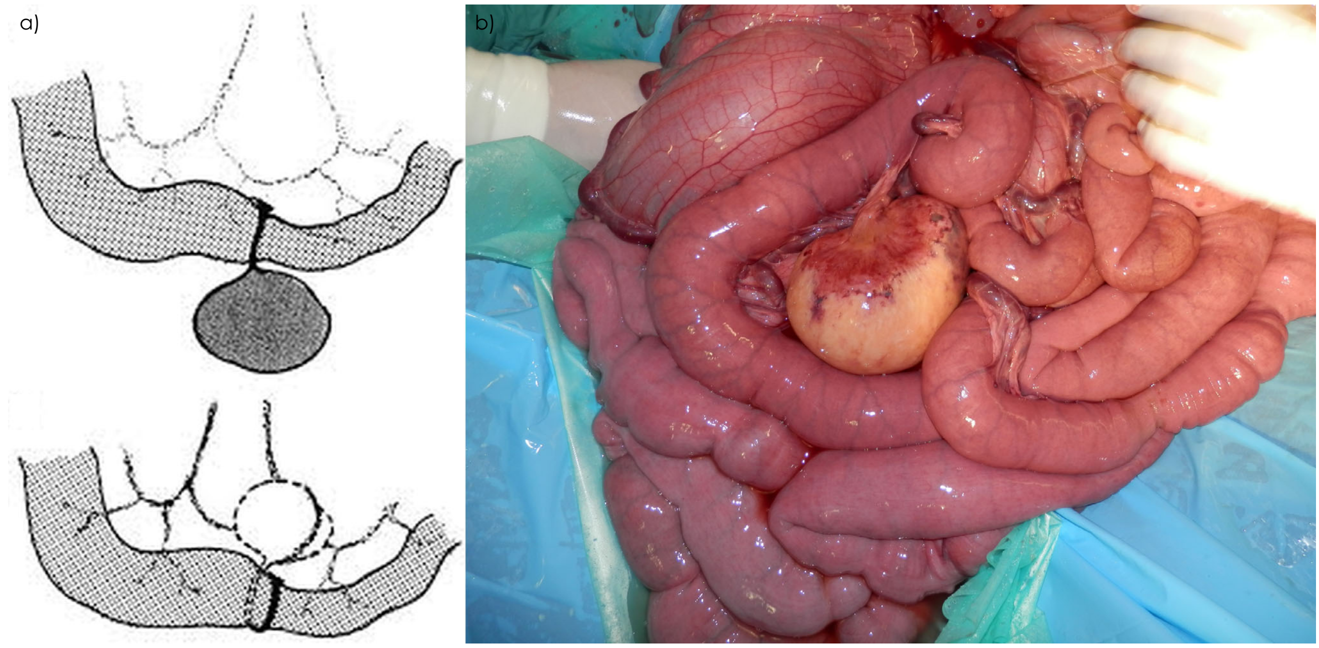

Fig 9: ***Short-stalked lipomas: a) mechanism for strangulation of the intestine by short-stalked lipomas as hypothesised by Edwards and Proudman (1994) (reproduced with permission from Equine Veterinary Journal). b) A large, short-stalked lipoma causing recurrent colics.***

case the omentum acts as a stalk. Despite being found in large numbers, lipoma of the small colon mesentery reportedly cause strangulation in only few cases (Edwards and Proudman 1994). Anatomy, content, weight, mobility and peristalsis of the small colon are very different from those of the small intestine and may not allow the movement of the loop of intestine necessary to cause strangulation as described in our model. Alternatively, this model cannot explain why in some cases only the mesentery is involved in the strangulation, as described by Bauck *et al*. (2020), and a completely different mechanism can be responsible.

Further studies and particularly clinical cases are needed to develop this technique. If the proposed mechanism is valid, administration of motility-inhibiting drugs (such as hyoscine, alfa-2 agonists or even opiates) in the early phases of the process, that is in the first visit by referring veterinarians, could reduce the amount of intestine entrapped and prevent involvement of the ileum. This may also apply to inguinal hernias and epiploic foramen entrapments, which undergo a similar process after entrapment according to Kopf (1985). The proposed mechanism could also underscore the importance of early referral, which could prevent the recruitment of a long segment into the entrapment and the tightness of the strangulation.

Clinical importance

Improved understanding of the manner in which intestine becomes entrapped by a lipoma could provide a method of resolving the strangulation. Strangulations by lipoma can be freed by transecting the stalk, sometimes blindly and deep in the abdomen, which could risk injury to major mesenteric vessels and mesentery (Freeman 2012). Reversing the direction followed by the lipoma during strangulation, based on our hypothesis, might be an easier and less risky alternative in some cases, especially if the tightness of strangulation was not exacerbated by tissue swelling.

Conclusions

The proposed hypothesis is intended to provide an alternative mechanism to explain strangulation by a pedunculated lipoma. The goal is to develop a better understanding of the process and thereby improving methods of correction.

Authors' declarations of interest

No conflicts of interest have been declared.

Ethical animal research

None.

Source of funding

None.

Authorship

All authors contributed to this hypothesis and preparation of the manuscript. All authors gave their final approval.

References

Archer, D. (2017) Diseases of the small intestine. In: *The Equine Acute Abdomen*, 3rd edn., Eds: A.T. Blikslager, N.A. White, J.N. Moore and T.S. Mair, Wiley-Blackwell, Hoboken, NJ. pp 704-770.

Bauck, A.G., Graham, A.S., Smith, A., Rapp, H.J. and Freeman, D.E. (2020) Mesenteric strangulation by pedunculated lipomas without involvement of associated intestine in four horses. *Equine Vet. Educ*. **32**, e141–e146. https://doi.org/10.1111/eve.13045

Blikslager, A.T., Bowman, K.F., Haven, M.L., Tate, L.P. Jr and Bristol, D.G. (1992) Pedunculated lipomas as a cause of intestinal obstruction in horses: 17 cases (1983–1990). *J. Am. Vet. Med. Assoc.* **201**, 1249-1252.

Downes, E.E., Ragle, C.A. and Hines, M.T. (1994) Pedunculated lipoma associated with recurrent colic in a horse. *J. Am. Vet. Med. Assoc.* **204**, 1163-1165.

Edwards, G.B. and Proudman, C.J. (1994) An analysis of 75 cases of intestinal obstruction caused by pedunculated lipomas. *Equine Vet. J.* **26**, 18-21.

Freeman, D.E. (2012) Small intestine. In: *Equine Surgery*, 4th edn., Eds: J. Auer and J. Stick, Elsevier Saunders, St Louis. pp 432.

Kilcoyne, I. and Nieto, J. (2020) Perplexing pedunculated lipomas. *Equine Vet. Educ.* **32**, 412-414.

Kopf, N. (1985) Über die Entstehung der Darmverlagerungen des Pferdes. *Pferdeheilkunde* **1**, 131-148.

Verwilghen, D., Hernlund, E., Ekman, S., Pringle, J., Johnston, C. and van Galen, G. (2013) Lipoma in recurrent colic. *Equine Vet. Educ.* **25**, 451-455.

Supporting information

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

Supplementary Item 1. Time-lapse video of the proposed hypothesis of intestinal strangulation by a pedunculated lipoma on an ex vivo model.