# Prune belly-like syndrome in two calves

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## SUMMARY

This paper reports two cases of abdominal muscular hypoplasia in new born calves, induced by the presence of intra-abdominal space-occupying malformations, and associated to other congenital disorders. In the first case, the calf presented slack dilated and floating abdomen associated to a small intestine with remarkably dilated sections (up to 10 cm of diameter) alternated with normal tracts, arthrogryposis of the anterior limbs, coxofemoral joints laxity and cryptorchidism. In the second case, abdomen of the calf appeared severely outstretched, with slack and floating wall, associated to 2 cystic dilations on the liver surface. These cases strongly resemble a congenital disorder of new born children known as prune belly syndrome, characterized by various degrees of abdominal muscular hypoplasia, bilateral cryptorchidism in males and urinary tract anomalies, that can be associated to other non-genital-urinary malformations affecting the gastrointestinal, skeletal and cardiopulmonary systems.

## KEY WORDS

Prune belly syndrome; calves; hepatic cyst; bowel dilation.

## CASE 1 DESCRIPTION

The first case was a 1-day-old male Holstein Friesian calf, admitted in 2007 to the Veterinary Teaching Hospital of the University of Milan for evaluation of a hanging abdominal wall that appeared extremely slack (Figure 1). On clinical examination, the calf was in sternal recumbency; body temperature was 39°C, respiratory rate was increased (88 breaths per minute) and caused spontaneous fluctuation of the abdominal wall. The calf showed arthrogryposis of the forelimbs, hind limbs muscular hypotrophy associated with coxofemoral joints laxity. The calf stood up only if assisted. When standing, he was reluctant to walk and showed rapid loss of balance. The abdomen appeared distended bilaterally and abdominal wall was very thin and flaccid. Bilateral abdomen auscultation revealed the presence of spontaneous fluid-splashing sounds induced by breathing movements. Testicles were not in the scrotum.

Abdominal ultrasonography showed a thin abdominal wall, where the only structures detected were skin and underlying connective tissue. Abdominal muscles were not identifiable. A small degree of peritoneal effusion was identified, accompanied by the presence of enlarged and completely atonic bowels, dilated by fluid content.

Standing lateral survey radiographs of the thorax and abdomen was performed. The radiographs showed complete fractures of the apophyses of the thoracic vertebrae T5-T10 with apex displacement, and distended loops of the intestine at all levels of the abdomen (Figure 2).

**Figure 1** - A 1-day-old male Holstein Friesian calf with extremely slack abdominal wall.

Twelve hours after admittance, the animal died and was immediately submitted to necropsy. At gross examination, the abdominal wall muscles were not detectable. The small bowel was diffusely reddish, filled with plenty serohaematic exudate and remarkably dilated sections (up to 10 cm of diameter) alternated with normal tracts (Figure 3). Kidneys were small and the bladder presented wall thickness reduction.

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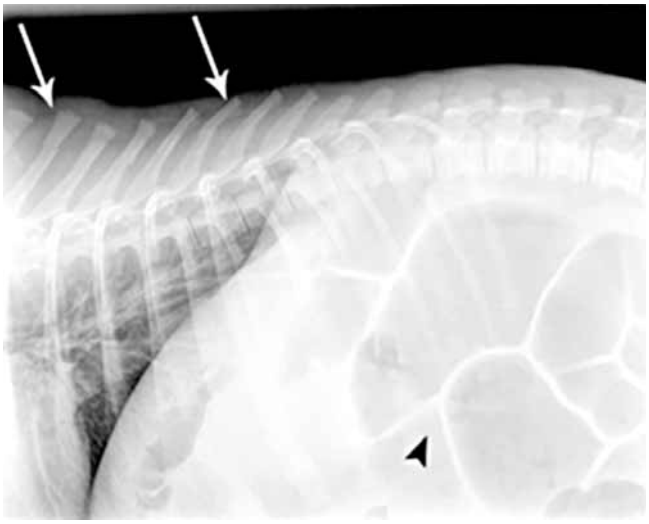

Figure 2 - Fractures of the apophyses of the thoracic vertebrae with apex displacement (arrows) and distended loops of the intestine in the abdomen (head of arrow).

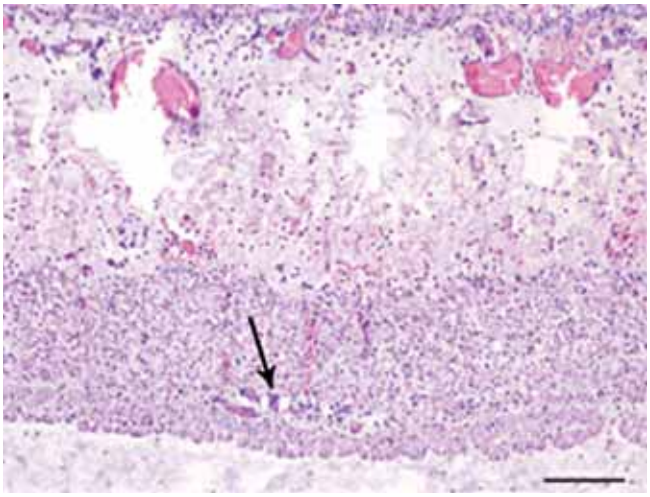

Figure 4 - Small intestine wall with oedema of the submucosa and diffuse haemorrhages involving the submucosa and muscular layer. Intramural nervous ganglia show degeneration (arrow); neurons are decreased in number. Haematoxylin and eosin. Bar, 150 µm.

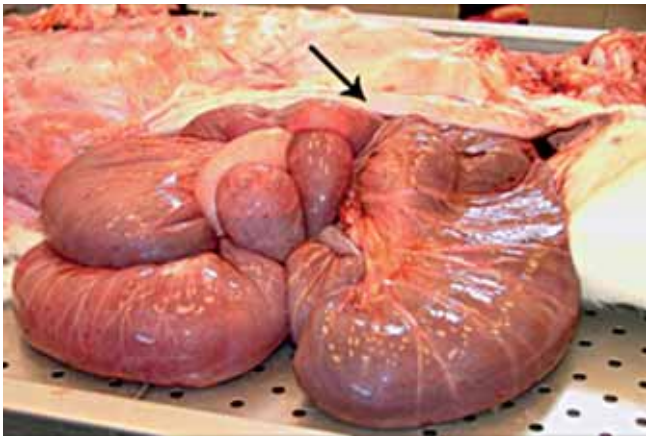

Figure 3 - Small intestine with severe and diffuse hyperaemia and dilation. The intestinal loops contents large amount of serohaematic exudate. The abdominal wall (arrow) is thin, whitish coloured and fibrotic, showing isolated tracts of hypoplastic muscular fibres in its structure.

Cerebral oedema was detectable too. Histological findings showed the almost complete and diffuse disepithelisation of intestinal mucosa; severe neuronal depletion in intramural ganglia was observed (Figure 4).

## CASE 2 DESCRIPTION

The second case was a 1-day-old female Holstein Friesian calf, admitted in 2016 for a severe abdominal distention. On clinical examination, the calf was lethargic and not able to stand; heart and respiratory rate were increased (160 beats and 92 breaths per minute, respectively). The abdomen appeared severely outstretched and its wall was slack and floating at every respiratory movement. Simultaneous ballottement and auscultation of left side abdomen evoked fluid-splashing sounds.

Abdominal ultrasonography showed a thin abdominal wall. There was a fluid collection extending from the umbilical region to the right hypocondrium. A 10 x 10 cm organized mass was found in relation with the ventral part of the liver; the mass appeared encapsulated with a hypoechoic content and internal echogenic septa. The calf was euthanized and submitted to necropsy. Gross examination showed abdominal dilation with severe thinning of the abdominal muscles. The colon was smaller in size with contraction of spiroid loops. The rumen contained a large amount of partially coagulated milk and the mucosa presented several hyperaemic areas. Liver surface showed 2 cystic dilations both containing serohaematic fluid (Figure 5). The first one was 20 cm large and showed a thin and transparent serosal wall (Glisson membrane), while the other one was roundish, 10 cm in diameter with a 6 mm thick fibrotic wall, where haemorrhages were detected. Small cysts were also found on the hearts valves (haematic cysts).

Histologically, the skeletal muscles of the abdominal wall were composed by hypotrophic and hypoplastic fibres. The liver showed hyperaemia, stasis and mild steatosis with vacuolar degeneration of hepatocytes. In the wall of the fibrotic cyst, bile ducts, few degenerated hepatocytes and haemosiderosis were also identified. The heart showed in-

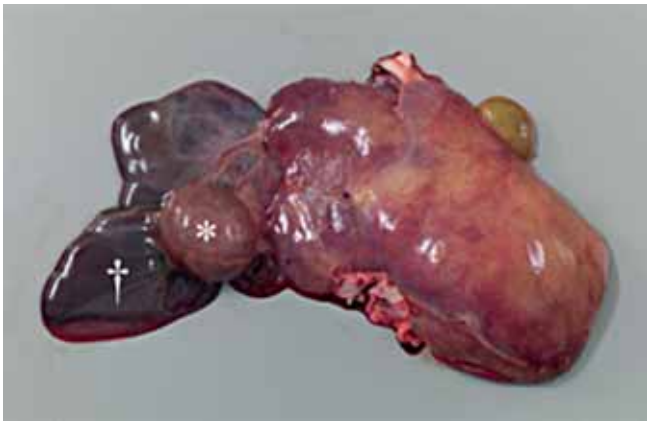

Figure 5 - Two cystic dilations on liver surface, both with serohaematic content. The largest (†), 20 cm wide, showed a thin and transparent wall, the other one (∗) was roundish, 10 cm in diameter with a 6 mm thick fibrotic wall.

travasal leukocyte margination and a mild widespread vacuolization of myocardial cells. Valvular haematic cysts were lined by a thin endothelial layer.

## DISCUSSION

Prune belly syndrome (PBS), also known as the Triad syndrome, Eagle-Barrett syndrome or Urethral Obstruction Malformation Sequence, is a congenital disorder of children characterized by varying degrees of abdominal muscular hypoplasia, bilateral cryptorchidism and urinary tract abnormalities including hydronephrosis, megaureters, vesicoureteral reflux and urethral malformations[1]. Congenital deficiency of the abdominal musculature was firstly described in humans by Fröhlich[2]. The term prune belly syndrome, originating from the characteristic wrinkled appearance of the abdominal wall in neonates, was coined for this complex by Osler[3]. Although the triad of signs remains a constant feature of PBS in new born children, pulmonary (58%), cardiovascular (25%), gastrointestinal (24%) and musculoskeletal (23%) malformations are associated to the syndrome[4].

Pathogenetical theories of PBS include urethral obstruction and a mesodermal developmental defect. The theory of urethral obstruction is mainly based on observation of postmortem specimens and anatomic features of infants with PBS[5]. Urethral obstruction causes bladder distension and urinary tract dilation in the developing foetus. This distension prevents normal abdominal musculature development and testicular descent[4]. This theory fits for cases of PBS with urethral atresia, but it does not explain cases where urethra is pervious[6]. The evidence of generalized prostatic hypoplasia in PBS patients[7], occurring for a focal insult to the developing urogenital sinus mesoderm, is supposed to induce a transient urethral obstruction during the 11$^{th}$-16$^{th}$ weeks of gestation, leading to the unsupported membranous urethra to twist, or creating a flap valve mechanism[8]. A second theory speculates an embryologic aberration of mesenchymal development. In fact, ureters smooth muscle, bladder, prostate, urethra, part of the kidneys, gubernaculums testis, and lower abdominal musculature origin from a pool of mesenchymal cells, composed by the three visceral layers[4,9]. Sutherland et al.[10] sustain that both theories may be correct. They found some cases of PBS derived from an obstructive process, and others from a primary mesodermal abnormality.

In veterinary medicine PBS was induced experimentally in a lamb by urethral obstruction during foetal life. At birth the lamb presented typical PBS abdominal wall, limb malformations and cryptorchidism[11]. A PBS case was suspected in a Rhodesian Ridgeback dog with prostatic anomalies[12]. In cattle, only one case has been ascribed to a prune belly-like syndrome[13]. In that case, the new born calf presented a pendulous abdomen and a thin abdominal wall. Pathological findings included hypotrophic abdominal muscles associated to multiple serous cysts at the level of the liver that would have been the cause of the abdominal distension during foetal life, leading to an impairment of muscular vascularization and development[13]. A moderate hypoplasia of the abdominal muscles is also reported in a new born calf with congenital hepatic fibrosis[14] and in a calf with congenital liver cysts[15]. Finally, in Italian Romagnola breed, a congenital disease called Calf Paunch Syndrome, characterized by enlarged and floating abdomen, hepatic fibrosis, abdominal effusion and facial dysplasia, has been described[16].

In our cases, the abdomen appeared severely outstretched with a slack and floating wall. This condition is a constant in PBS, where all the affected children presented hypoplasia of abdominal muscles[4]. It seems that, in case of PBS, abdominal muscle hypoplasia and abdominal distension are caused by urinary tract dilatation during foetal life[4]. A malformation similar to PBS has been described: in that case, abdominal wall hypotrophy was related to the presence of a large liver cyst associated to malrotation in foetal life, but no genitourinary malformations were detected[17].

As in the case described by Astiz Blanco et al.[13], our second calf presented a liver cyst. It may be that the cyst was larger during early foetal life, causing an impairment of abdominal wall development, and reduced its size near birth[13,17]. In human cases, the presence of a hepatic cyst was related to a mesenchymal hamartoma that spontaneously disappears before birth[17]. In cattle, congenital liver cysts are uncommon. Nogradi et al.[15] described a liver cyst in an Angus bull calf with enlarged, pendulous abdomen that recovered after surgical removal.

On the other hand, our first calf presented cryptorchidism and small intestine multiple dilations; gastrointestinal malformations, are often associated with PBS in humans[4,17]. Moreover, this animal presented various musculoskeletal anomalies characterized by arthrogryposis of the anterior limbs, weakness and muscular hypotrophy of the posterior limbs as well as laxity of coxofemoral joints. In infants affected by PBS, musculoskeletal malformations are often observed, in particular scoliosis, arthrogryposis, congenital hip dislocation and club feet[18]. Limb deformities were detected even in the lamb PBS experimentally induced[11]. The pathogenesis of skeletal malformations in PBS is still debated, even if it best correlates with the embryologic theory of an aberrant mesenchymal development[18].

In conclusion, the presence of large intra-abdominal masses, represented respectively by bowel dilations and liver cysts during foetal life, may have led to abdominal muscles hypotrophy and to a prune belly appearance. These findings lead Authors to classify these cases as prune belly-like calves. Our findings in calves support the pathogenetical theory that attributes the failure in development of abdominal muscle to abnormal distension of abdomen during foetal life, regardless of the cause of distension.

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