Scientific Report

Giant hydronephrosis and secondary pyelonephritis induced by *Salmonella dublin* in a Holstein calf

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Summary

Hydronephrosis occurs as a congenital or an acquired condition following obstruction of the urinary tract. In this study, a four month old male Holstein calf with emaciation, growth retardation and a poor dry scruffy hair coat was examined because of remarkable distention of right abdomen. At necropsy, right kidney was hydronephrotic as a very big fluid-filled round pelvis with the presence of multilocular cysts bulged from the cortical surface. With sectioning, more than 10 L of bloody fluid poured out from this sac. Microscopic examination showed severe atrophy of cortical tissue and fibrosis of the medulla. Also, the dilated pelvis was composed of fibrinous exudate and necrosis of epithelium associated with multifocal aggregations of neutrophils and bacterial microcolonies. In a culture and serotyping of isolated bacteria, *Salmonella dublin* was determined. In conclusion, *S. dublin* induced pyelonephritis secondary to congenital giant hydronephrosis is the first report in cattle in the world.

Key words: *Salmonella dublin*, Hydronephrosis, Pyelonephritis, Holstein calf

Introduction

Hydronephrosis refers to dilation of the renal pelvis and calyces associated with progressive atrophy and cystic enlargement of the kidney (Maxie and Newman, 2007). It occurs as a congenital or an acquired condition following obstruction of the urinary tract (Radostits *et al*., 2007). Hydronephrosis occurs in human beings and all domestic animals. In medicine, giant hydronephrosis is defined as a condition caused by the accumulation of more than 1000 ml in the excretory system of either kidney (Mediavilla *et al*., 2013). Urinary stasis predisposes an infection, and hence pyelonephritis may be superimposed upon hydronephrosis (Maxie and Newman, 2007; Divers and Peek, 2008). *Salmonella* urinary tract infections are rare and uncommon. In ruminants, pyelonephritis most often results from ascending urinary tract infection with *Corynebacterium renale* or *Eschrichia coli* but hematogenous route is much less common and may result from bacteremia with such agents as *Salmonella* species or *Actinomyces pyogenes* (Divers and Peek, 2008; Smith, 2009). To the best of our knowledge, this is the first report of isolation of *Salmonella dublin* from pyelonephritis superimposed upon giant hydronephrosis in cattle.

Case presentation

In autumn 2013, a four month old male Holstein calf was referred for diagnosis of illness because of remarkable distention of right abdomen. The calf apparently had normal feeding, mastication, urination and defecation. Compared with normal male calves at this age, this calf was smaller with growth retardation, emaciated and had a poor dry scruffy hair coat. In physical examination, no abnormal findings were observed. The body temperature, respiratory and heart rates were in normal ranges. Palpation of right abdomen showed a tense abdomen with remarkable distention of flank without any pain. Because of poor prognosis for economic recovery and on the basis of the request of the owner, the animal was slaughtered. The systematic necropsy was done. The cyst content was examined bacteriologically on basis of Quinn *et al*. (2011). For histopathological examination, appropriate tissue samples of kidneys, heart, lungs, intestines, and liver were fixed in 10% neutral buffered formalin, processed and embedded in paraffin. Sections of 5 µm were cut, stained with haematoxylin and eosin (H&E), and studied microscopically.

Results

At necropsy, right kidney was hydronephrotic as a very big fluid-filled round pelvis about 30 × 30 × 40 cm in size, with the presence of multilocular cysts about 4 × 4 × 4 cm in size bulged from the cortical surface (Figs. 1 and 2). With sectioning, more than 10 L of bloody fluid

poured out from this fluid-filled sac. The sac wall was thin, about 5 mm, so that the medulla was absent and the cortex was very thin and atrophic. Cortical multilocular cysts were full of relatively clear fluid and they were communicated with the dilated pelvis. The internal surface of cortical cysts was smooth, glistening and white in color but dilated pelvis was necrotic with brownish debris. With regard to chronicity of the lesion, amount of fluid and the age of animal, the hydronephrosis was diagnosed as congenital. Left kidney was to some extent bigger than normal but the gross appearance was normal. There were no abnormal changes in other parts of the body. The isolated bacteria belonged to Enterobacteriaceae family, genus of *Salmonella* on the basis of biochemical results of cultures. Serotyping of isolated *Salmonella* showed serogroup D1, O antigen (1.9, 12) and H antigen Phase 1 (g, p) and was diagnosed as *S. dublin*.

Fig. 1: Necropsy finding, calf, right kidney is observed hydronephrotic as a very big fluid-filled round sac in the abdomen

Fig. 2: Giant hydronephrosis as a very big fluid-filled round pelvis about 30 × 30 × 40 cm in size with presence of multilocular cysts bulged from the cortical surface

Microscopically, severe atrophy of cortical tissue and fibrosis of medulla were observed in the right kidney. In thinned cortical parenchyma, a number of atrophic tubules and glomeruli associated with condensed interstitial connective tissue were observed (Fig. 3). Instead of the medulla, a thick layer of dense connective tissue contained a few scattered accumulations of mononuclear inflammatory cells and hemosiderin-laden macrophages were seen. In addition to fibrosis, the thin-walled sac of the dilated pelvis was composed of fibrinous exudate and necrosis of transitional epithelium associated with multifocal aggregations of neutrophils and bacterial microcolonies (Fig. 4). Therefore, pyelonephritis superimposed giant hydronephrosis was diagnosed. Microscopic structures of left kidney, heart, lungs, ileum, colon and liver were normal.

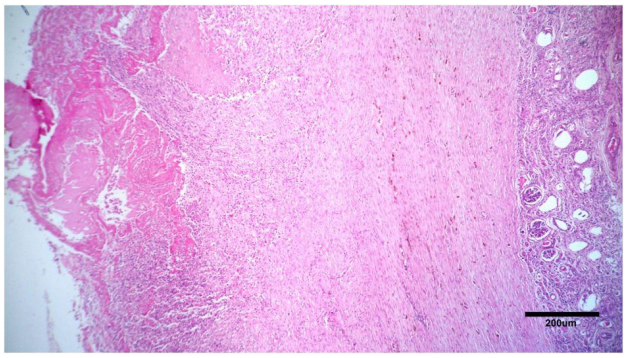

Fig. 3: Chronic hydronephrosis, atrophy and fibrosis of cortical tissue and advanced fibrosis of medulla are observed (H&E, Bar 200 µm)

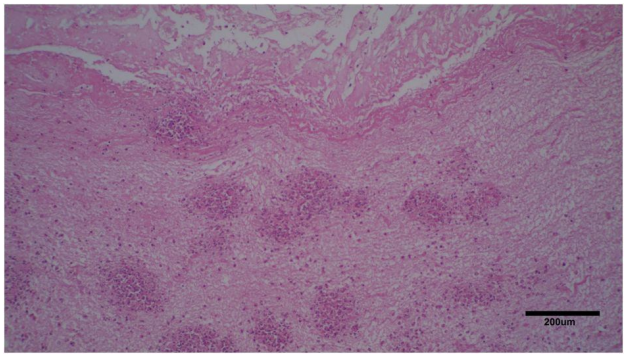

Fig. 4: Pyelonephritis superimposed chronic hydronephrosis, fibrinous exudate associated with multifocal aggregations of neutrophils and bacterial microcolonies in the necrotic pelvis are seen (H&E, Bar 200 µm)

Discussion

Infections due to *Salmonella* spp. remain a global problem. These infections may cause significant morbidity and mortality both in humans and production animals as well as considerable economic losses. Illness associated with *S. dublin* can be difficult to treat, may be fatal, and the environment, once contaminated, may be difficult to clean up. People, other livestock and companion animal species are also susceptible to infection and could suffer serious illness. Carrier animals can maintain the infection within a herd and may continue to shed organisms contributing to repeat exposure of healthy and sick animals. *Salmonella* spp. usually enters the urinary system via the blood or lymphatics. In human, several cases of symptomatic *Salmonella* urinary tract infections with male predominance have been reported so that most of the infections were located in the upper urinary tract (Cohen *et al*., 1987; Al-Otaibi, 2003). Nearly all cases were immunocompromised (having malignancies or were

transplant recipients), had pre-existing pathological changes such as nephrolithiasis, hydronephrosis, and anatomical anomaly. In endemic areas, urinary schistosomiasis has been an important predisposing factor for *Salmonella* infection, as the organisms establish themselves in the damaged tissues and produce chronic infection (Newman, 2011).

The pathogenesis of hydronephrosis is based on the persistence of glomerular filtration in the presence of urinary obstruction, plus the development of ischemic lesions. The degree of development of hydronephrosis depends on whether or not it is bilateral, the completeness of the obstruction, and on other complications of obstruction. The development of an extensive degree of hydronephrosis requires that it be unilateral (Maxie and Newman, 2007).

Unilateral hydronephrosis is caused by obstruction of the ureters anywhere throughout its length or at its entrance into the urinary bladder. If the obstruction is unilateral, the unaffected kidney can compensate fully for the loss of function and the obstruction may not cause kidney failure (Radostits *et al*., 2007).

The most common causes of hydronephrosis are congenital anatomical anomalies, urolithiasis, chronic inflammation, ureteral or urethral neoplasia and neurogenic functional disorders (Newman, 2011). Hydronephrosis and renal failure have been reported in cows (Friesen *et al*., 1995; Chandler *et al*., 2000). Hydronephrosis due to chronic partial obstruction of the penile urethra by a urolith, partial obstruction of the ureters by papillomas of the urinary bladder and also compression by neoplastic tissue in cases of enzootic bovine leukosis have been reported as well (Skye, 1975; Goldschmidt, 1981; Aldridge and Garry, 1992; Radostits *et al*., 2007). Urinary stasis predisposes an infection, and hence pyelonephritis may be superimposed upon hydronephrosis (Maxie and Newman, 2007). Hydronephrosis and pyelonephritis associated with an anomalous vasa deferens was reported in a two years old Limousin bull (Tyler *et al*., 1991).

Unlike most other types of *Salmonella* bacteria, *S. dublin* has a tendency to reside in the herds for years or decades, mainly due to its ability to produce persistently infected carriers that shed bacteria to the environment either continuously or periodically. In this report, congenital anatomical anomaly like atresia of ureter caused chronic obstruction predisposing to the hydronephrosis and secondary pyelonephritis. In conclusion, *S. dublin* induced pyelonephritis secondary to congenital urinary stasis and chronic cystic hydronephrosis is the first report in cattle in the world.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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