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Review

Traumatic urinary bladder injuries in small animals

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Traumatic urinary bladder injuries in the recent times are considered to be of great importance in veterinary medicine, as they can lead to significant morbidity and subsequent mortality when diagnosed late or left untreated. However, the true incidence rates, absolute treatment recommendations and prognoses of lower urinary tract traumas are not available in literatures as the majority of specific information regarding lower urinary tract injuries in small animals exist as isolated case reports or small case series. Urologists may only encounter traumatic bladder injuries in their practice, because of the current modernization and human activities leading to increase in occurrence of the injuries. This paper reviews mainly the literatures and reports on the causes, clinical signs, diagnosis and management of traumatic urinary bladder injuries (blunt, penetrating and iatrogenic bladder traumas) to assist clinicians in this specialty. History, presenting clinical signs and laboratory evaluations are the diagnostic tools of bladder injuries and in predicting prognosis when treated. Despite presentation with nonspecific signs, haematuria and abdominal tenderness are the most common clinical signs of bladder rupture in animals. Early diagnosis and repair of bladder rupture offers good prognosis. Management of these conditions may require either solely medical or surgical intervention, while others will require a combined management intervention.

Key words: Injuries, review, small animals, traumatic, urinary bladder.

INTRODUCTION

Trauma of lower urinary tract is frequently recognized in veterinary patients and is the most common cause of uroperitoneum in cats, dogs, and humans (Aumann and Worth, 1998; Gannon and Moses, 2002; Rieser, 2005). In the previous decades, traumatic (blunt or penetrating) bladder injuries were considered to be relatively uncommon in animals mainly due to the anatomical position of the bladder, located within the bony structures of the pelvis and is protected from most external forces (Fletcher and Clarkson, 2011). However, as the bladder fills, it moves into the abdomen and makes it more vulnerable to be ruptured or injured (Bartges and Polzin, 2011). In the young animals, the pelvic bones are not fully developed and so it is more easily injured than in the adult animals (Dyce et al., 2003).

Currently, urinary bladder rupture is the most common traumatic urinary injury in dogs and cats (Thornhill and Cechner, 1981). It is more common in male dogs due to less urethral compliance and dilation in response to increased intravesicular pressure (Thornhill and Cechner, 1981). Mechanisms for bladder rupture include direct penetration by fracture fragments or sudden increase in

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intravesicular pressure (Selcer, 1982). Multiple severe injuries involving the urinary bladder are common with abdominal trauma (Selcer, 1982; Cass, 1984; Weisse and Aronson, 2002) and mortality in these patients is alarming, 12 to 22% (Corriere, 1986; Cass and Luxenberg, 1987). In a study of 1,000 consecutive veterinary trauma patients evaluated at a single hospital, approximately 12% had significant abdominal injuries with involvement of the urinary bladder in some cases (Kolata and Kraut, 1974). Sura (2011) reported that, between 1966 and 1971, ruptured urinary bladder was confirmed in 26 dogs and 14 cats at one institution; 84.6% were due to trauma and 46.2% had associated pelvic fractures (Burrows and Bovee, 1974). Similarly, urinary bladder rupture has been reported by Whitney and Mehlhaff (1987) and Vnuk and Pirkic (2003) in 1/119 and 3/132 cats, respectively with high-rise syndrome. Also undifferentiated abdominal injury has been reported in 12/81 dogs injured by this same mechanism (Gordon and Thacher, 1993).

The true incidence rates, absolute treatment recommendations and prognoses of lower urinary tract trauma are not available in literatures as majority of the specific information regarding lower urinary tract injuries in companion animals exists as isolated case reports or small case series (Sura, 2011). In recent time of modernization increase incidence of bladder injuries is expected as a result of modern transportation preferences for both humans and their animals, increasing reliance on motor vehicles with advances in engine and mobile parts technology (Dobrowolski *et al.,* 2002). Domestic or professional accident and violence including terrorist activities also contribute to the increasing frequency of bladder injury (Dobrowolski et al., 2002).

It is well established that prompt recognition and early management of these urological injuries can significantly reduce morbidity and mortality (Kong et al., 2011; Sura, 2011). Delay in diagnosis of urinary tract trauma increases mortality rate (Sura, 2011). Death occurs 47 to 90 h after experimental urinary bladder rupture (Burrows and Bovee, 1974), although in traumatic cases, mortality is typically from associated sustained injuries (Aumann and Worth, 1998).

AETIOLOGY OF TRAUMATIC BLADDER INJURY

Lower urinary tract injury may be caused by external or iatrogenic trauma (Sura, 2011). Similarly, acquired urinary bladder injuries can occur as a result of either external (blunt or penetrating) or iatrogenic trauma with similar frequency (Carlin and Resnick, 1995). Kolata and Johnston (1975) reported that out of 600 consecutive dogs injured in motor vehicle accidents, 2.5% had urinary tract trauma. Additionally, a study of 100 consecutive dogs sustaining pelvic fractures found that 39% had urinary tract injury detected with contrast radiography and the incidence of injury did not correlate with the severity of fracture (Selcer, 1982). In human patients, it is estimated that 10% of adult humans with external trauma sustain urinary tract injury (Tezval and Tezval, 2007).

According to Khan et al. (2004) in a retrospective review of hospital records, over a 10-year period, reported that bladder trauma due to motor vehicle collisions accounted for 35%, iatrogenic causes 35%, falls responsible for 20% and gunshot wounds amounted to 10% of the injuries in 260 identified patients with bladder injuries. Similarly, a 5-year survey from 61 urological departments by Dobrowolski et al. (2002) recognized 512 cases of bladder injuries out of which 210, 251, 41 and 10 were due to motor vehicle collision, iatrogenic, falls from height and crush injuries respectively.

Clinical signs

Evidence of urinary tract injury may not be apparent initially and development of clinical signs can be protracted (Bjorling, 1984; McLoughlin, 2000; Rieser, 2005). Clinical signs of lower urinary tract injury may be associated with uroperitoneum which include abdominal pain, dehydration, ballotment of a fluid wave, hematuria or dysuria, progressive depression, hypothermia, and other signs of external trauma (Burrows and Bovee, 1974; Pechman, 1982; Gannon and Moses, 2002).

The clinical signs of bladder injury are relatively nonspecific (Kong et al., 2011). Presence or absence of hematuria, ability to void voluntarily, and presence of a palpable bladder do not predict urinary tract integrity (Burrows and Bovee, 1974; Rieser, 2005). Delayed signs are those of uremia and peritonitis, and may be suggestive of other organ or system abnormalities (Rieser, 2005). In a study on 26 cats with uroperitoneum, the most common historical complaints, other than anuria, were vomiting and lethargy (Aumann and Worth, 1998). Vomiting may begin approximately 24 h prior to detection of severe azotemia (Burrows and Bovee, 1974). Presence of infected urine in the abdomen may lead to systemic sepsis (McLoughlin, 2000). It is also reported in a study that there is strong correlation that exist between pelvic fracture and gross haematuria in patients with bladder rupture, where 85% of the patients that sustained pelvic fracture also presented gross haematuria (Morey et al., 1999). Kong et al. (2011) stated that, 100% of all patients with bladder injuries present gross haematuria and its presence in conjunction with pelvic trauma is a well-documented predictor of the injury. Although, clinical signs of bladder injury are nonspecific, Bartges and Polzin (2011) published works on clinical and experimental studies of urinary bladder rupture, where the earliest clinical sign noted was abdominal tenderness, and then later followed by vomiting. Progressive dehydration and uremia eventually culminates into death within 72 h (Meynard, 1961; Burrows and Bovee, 1974).

Diagnosis

Generally, diagnosis of bladder trauma is primarily based on case history of the patient, presenting clinical signs, and laboratory evaluations.

The historical evaluation should include relevant information on possible exposure to traumatic object(s), frequency of urination, volume of urine produced, changes in water intake, appearance and odour of urine, and the presence or absence of polysystemic signs of disease (Bartges and Polzin, 2011). General information that should also be gathered from pet owners include information on husbandry, appetite, diet fed, medications administered, vaccination and deworming status, possible exposure to infectious agents or toxins, changes in behaviour, etc (Bartges and Polzin, 2011).

As many of these animals are presented after sustaining blunt trauma, extreme caution and close monitoring of the patient are essential, as a previously unsuspected diaphragmatic defect may become apparent (Carter and Wingfield, 1989; Dzyban and Labato, 2000). Common presenting clinical signs of bladder trauma are associated with uroperitoneum including azotemia, hyperkalemia, hypernatremia, hyperphosphatemia, and metabolic acidosis (Gannon and Moses, 2002; Rieser, 2005)

Abdominocentesis is necessary to definitively diagnose uroabdomen (Sura, 2011). Although different imaging techniques including retrograde cystography (urethrocystography) (Sandler et al., 1998; Feeney and Anderson, 2011), cystoscopy (Gilmour et al., 1999; Byron and Chew, 2011), ultrasonography (Bigongiari and Zarnow, 1994; Helling and Wilson, 2007; Hecht and Henry, 2011), computed tomography, angiography, and magnetic resonance imaging (Ben-Menachem et al., 1991), excretory urography (Werkman et al., 1991; MacLeod and Wisner, 2011) as well as surgical exploration (Allen et al., 2001) are employed as diagnostic tools.

Survey thoracic and abdominal radiography are obtained in all cases of trauma to evaluate diaphragmatic integrity, identify pneumothorax, hemothorax, pulmonary contusions and pertinent fractures (Sura, 2011). Radiographic evidence of urinary tract trauma includes loss of abdominal or retroperitoneal detail, lack of a distinct urinary bladder, and displacement or nonvisualization of a kidney (Pechman 1982).

The most reliable noninvasive means of detecting urinary tract trauma is via contrast radiography (Pechman, 1982; McLoughlin, 2000). Urethral tears and bladder rupture can be visualized by urethrocystography, although complete filling of the urinary bladder is required to demonstrate small defects (McLoughlin, 2000).

However, the standard and most accurate diagnostic procedure for detecting bladder rupture is the retrograde cystography (urethrocystography) (Baniel and Shein, 1994; Sandler et al., 1998; McLoughlin, 2000; Feeney and Anderson, 2011) with accuracy rate of 85 to 100% (Sandler et al., 1998; Deck et al., 2000) and it is usually made easily on cystography when the injected contrast is identified outside the bladder (Lynch et al., 2003). In a study of experimental urinary tract rupture in 14 dogs, contrast cystography diagnosed 100% of cases (Burrows and Bovee, 1974). Similarly, positive contrast urethra-cystography delineated all cases of urinary bladder and urethral trauma in dogs with pelvic fractures (Selcer, 1982).

Management

Opinion has now changed regarding surgical management of urinary bladder rupture. Speed was considered of optimum concern due to rapid deterioration of patient's status (Meynard, 1961). Currently, medical treatment of patients with traumatic bladder injuries is prioritized in most accidents and as an emergency intervention. The first priority is medical stabilization of the patient before reparative intervention is attempted, and treatment of associated life-threatening injuries (Lynch et al., 2003; Sura, 2011) to establish lack of an underlying cause for rupture, hypotonicity of the bladder, evidence of devitalization, urosepsis, and other reasons for celiotomy (Osborne and Sanderson, 1996). Nonsurgical management of traumatically ruptured urinary bladder has also been reported in children, resulting in a shorter hospital stay and equivalent outcome to those surgically managed (Osman and El-Tabey, 2005).

Urinary drainage and diversion is essential in treating urinary bladder trauma. Extraperitoneal ruptures can be managed safely in certain instances by simple catheter drainage (that is, urethral or suprapubic catheterization) and it should be left indwelling within the urinary bladder (Bartges and Polzin, 2011). After 3 to 5 days of catheterization, a contrast cystourethrogram is performed. If urinary leakage is still present, catheterization may be continued. An abdominal drainage catheter may also be used in conjunction with urethral catheter. Once cystourethrography has proven that leakage has ceased, the catheters are removed and the animal is monitored for voluntary urination. All catheters should be submitted for bacterial culture at the time of removal, as the odds ratio for development of a urinary tract infection increases approximately 27% for each day of catheterization (Bubenik and Hosgood, 2007).

Virtually all extraperitoneal bladder injuries heal within three weeks, except in bladders with extensive extraperitoneal extravasation that often require surgical intervention (Jong et al., 2004). If catheterization is impossible (as in most cases of intraperitoneal bladder ruptures), drainage can be achieved via cystocentesis, cystostomy tube placement, or urinary bladder marsupialization (Bjorling, 1984). Cystostomy and marsupialization require general anesthesia; intermittent

cystocentesis may be preferred in the severely compromised animal (Bartges and Polzin, 2011). To address urine accumulation in the peritoneal cavity, a peritoneal catheter can be placed to lavage and evacuate it (McLoughlin, 2000). Most, if not all, intraperitoneal bladder ruptures require surgical exploration (where a midline celiotomy is performed, the defect in the bladder wall located, debrided, and closed with fine absorbable suture), because of the severity of associated injuries, and usually have a high mortality rate of 20 to 40% (Thomae et al., 1998; Awasum, 2010). Lacerations are usually large in these cases, with the potential risk of peritonitis due to urine leakage (leading to uroperitoneum and subsequent uroperitonitis) and infection if left untreated (Morey et al., 1999; Jong et al., 2004). All bladder perforations due to penetrating trauma should undergo emergency exploration and surgical repair (Morey et al., 1999).

BLUNT TRAUMA

Blunt trauma occurs when extensive external force exerted on the abdominal wall displaces the bladder to an unbearable elastic (stretch) limits such that the bladder wall gets weakened and sometimes may lead to tears. Blunt trauma injuries of the urinary bladder have been reported by Carroll and Mc Aninch (1984) to accounts for 67 to 86% of bladder ruptures, and may be classified as either extraperitoneal with leakage of urine limited to the perivesical space, or intraperitoneal, in which the peritoneal surface is being disrupted with concomitant urinary extravasation into the peritoneal cavity.

When extraperitoneal blunt trauma occurs as a consequence of blunt pelvic trauma resulting to lacerations or punctures due to bone fragment(s) and shearing of ligamentous attachment(s) due to pelvic and other long bone fractures (Dreitlein et al., 2001), the consequences are grievous. Intraperitoneal blunt trauma can occur due to high velocity blunt lower or caudal abdominal trauma and high intravesical pressure with rupture injuries at dome. It is characterized by high rate of associated intra-abdominal escape of urine and mortality (Dreitlein et al., 2001). These conditions are usually expressed with an exhibition of intense pain and haematuria. Unlike in penetrating urinary bladder trauma which makes diagnosis easier, blunt trauma injuries are often confused with medical causes of ascites or aetiologies of distended abdomen.

Diagnosis of blunt trauma or injury of urinary bladder is by multiple diagnostic procedures since it occurs in the context of multisystem trauma. This can be achieved by retrograde cystography, computed tomographic (CT) scan of the pelvis after retrograde instillation of bladder contrast, or during surgical exploration (Allen et al., 2001). Intraperitoneal bladder rupture can be handled by exploration and primary bladder closure or laparoscopic repair (Gunnarsson and Heuman, 1997), while the extraperitoneal bladder injury is predominantly managed conservatively, with 2 weeks of indwelling Foley catheter drainage (Allen et al., 2001). Management of intra-peritoneal bladder rupture (by exploration and primary bladder closure) has a lesser success rates compared to laparoscopic repair due to late presentation, lack of specialized equipments and diagnostic ability, length of hospital stay and infection risk (Suad et al., 2011).

PENETRATING TRAUMA

Penetrating trauma usually results from high-velocity gunshots or sharp stab wounds to the suprapubic area leading to direct injury to the bladder wall, and is commonly associated with injury to other organs (Dreitlein et al., 2001; Jong et al., 2004). Penetrating trau-ma tends to be more severe and less predictable than blunt trauma (Anonymous, 2009). Morey et al. (1999) suggested that, all bladder perforations resulting from penetrating trauma should undergo emergency exploration and repair.

IATROGENIC BLADDER INJURY

Due to intimate association of urinary bladder and other visceral organs, Christopher et al. (2011) reported that, iatrogenic bladder injuries are occasional complications of surgeries performed in the pelvis or caudal abdominal region, because of the close proximity of the bladder to the rectum in males and to the uterus in females. Thus, there is the potential for iatrogenic injury occurring during surgical dissection of the aforementioned structures. Iatrogenic bladder injuries that occur as complications in gynaecologic surgeries are of high incidence (Gambini et al., 2001; Dobrowolski et al., 2002) especially in ovarian cystectomy (Mteta et al., 2006), caesarean section, hysterectomy, hernioplasty, ovariohysterectomy, and other emergency surgeries close to the urinary bladder (Christopher et al., 2011).

Early diagnosis and repair offers the best outcome in the management of iatrogenic bladder injuries. Delayed diagnosis often leads to the development of local infection, which usually progresses to sepsis; thereby, complicating repair, impairing wound healing and producing poor outcomes (Gómez et al., 2004).

Diagnosis involves cystography in which any discontinuity or disruption of the continuity of the bladder silhouette is positive for diagnosis of bladder rupture.

Ascending or retrograde contrast cystography is also advocated for this purpose. Continuous bladder drainage should however be maintained from repair until cystography confirms the integrity of the bladder repair. Perivesical drainage is recommended but should be removed after 48 h post-operatively unless there is bleeding

bleeding or extravasation of urine, which suggests an imperfect repair (Dobrowolski et al., 2002).

CONCLUSION

Lower urinary tract (bladder) trauma in small animals is one of the specialized and important injuries that can have significant consequences if not recognized early or left untreated. Recognizing and treating the injury can be difficult in a multitrauma patient. In general, when the index of suspicion is high, emergency intervention should be prioritized.

Conflict of interest

The authors declare that there is no conflict of interest.

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