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Humeral Fracture in Heavy Pregnant Buffaloes; an Overview

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ABSTRACT

The purpose of this study was to highlight the possible causes of humeral fracture in mature pregnant buffalos at late gestation, in order to reduce its economic losses caused by slaughtering of the animal with the subsequent loss of the offspring and milk production. This study was performed over 3 years. Anatomical characteristics of the right and left humerus of mature buffalos were evaluated in fifty specimens (right and left of the same animals) using gross and radiological examinations (X-rays and CT). Biochemical analysis of blood serum samples collected from 45 mature female Egyptian buffalos was performed using the spectrophotometric method. The result of the present study indicated that humeral fracture (especially) in pregnant Egyptian buffalos during the last period of gestation have anatomic and metabolic factors, which interact and attribute to render the bone liable to fracture with minimum amount of stress. During this critical period, the heavy pregnant buffalos female requires careful management and handling.

Key words: Fracture, Humerus, Buffalo.

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INTRODUCTION

Buffalos constitute an important part of domestic animal resources in Egypt and many other countries (Bhatt 1999, Wilson, 2012). The transition period, which occurs shortly before and after parturition is characterized by a greatly increased risk of disease, which, increases the culling rate of the animal (Stevenson and Lean, 1998). It is important to adapt the pregnant female during the last trimester of gestation in order to reduce the risk of metabolic disorders (DeGaris and Lean, 2009).

Metabolism of major elements (phosphorus, calcium, and magnesium) in ruminants undergoes hormonal regulation. Parathyroid hormone (PTH), cholecalciferol, calcitonin (CT) and to a lesser degree gonadal hormones influence the absorption of these elements from the digestive system, accumulation or removal from the skeleton and the amount of their excretion through urination (Bednarek et al., 2000).

Fractures of long bones are common in large animals (Crawford and Fretz, 1985; Arican, 2014). In between long bone fractures in large animals, the fracture of humerus is the least common type in cattle (Rakestraw et al., 1991; Rakestraw, 1996; Arican, 2014). This can be attributed to the anatomical characteristics and the location of the humerus. The humerus is a short and thick bone and highly protected laterally by a heavy muscular mass and medially by the thoracic wall (Ferguson, 1982; Denny et al., 1988; Markel et al., 1988; Rakestraw, 1996; Ferguson, 1997). Humeral fracture in cattle and horses usually occurs as a result of trauma or accident. The fracture line usually spiral or oblique and extends through the diaphysis with different degrees of communication (Tulleners, 1986; Rakestraw et al., 1991). It usually occurs close to the radial nerve with a high risk of permanent neurologic damage (Ferguson, 1997).

Several treatment options have been proposed for the management of humeral fractures in calves and heifers. The treatment method depends on the size, age, temperament and economic value of the animals and the experience of the surgeons (Rakestraw, 1996; Ferguson, 1997; Yamagishi et al., 2014).

In north Egypt, buffalos (especially the pregnant ones at the last stage of gestation) were subjected to much surgical affections. From the economical point of view, fractures of long bones are the most serious ones. With the difficulty in treatment of such cases, culling and slaughtering of the animal is the beast choice, which, leads to great economical losses by loss of the offspring and the subsequent milk production.

During the last few years that fracture of the humerus especially the left humerus is the most common type of long bones fractures in mature buffalos especially at the last stage of gestation (Rakestraw, 1996). Although, no data about the causes of such cases were available. The present study aims to highlight the possible causes of humeral fracture in buffalos especially at late pregnancy.

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MATERIAL ANA METHODS

The place of study and experimental design

During July 2012 to July 2015 with field trips performed by the faculty in the Menoufia governorate, Egypt, 121 cases of adult female Egyptian buffalos were referred for lameness examination and diagnosis. The animals were 5-15 years of age and 500- 650 kg of body weight. 87 cases from the referred animals were in the dry period and 34 cases were non-pregnant. All cases were severely lame and had demonstrated non-weight bearing on one of the fore or the hind limbs for one to four days before the examination. In the final diagnosis, the study showed that nearly half of the examined cases (56 cases) suffered from humeral fracture (44 cases with left humeral fracture and 12 cases with right humeral fracture). Fracture of the humerus was diagnosed on the bases of clinical examination of the affected animals and confirmed by the necropsy findings after slaughtering of the animals (nearly all cases were slaughtered by the owner's request out of fear of the complications associated with fracture). In clinical examination, the study recorded typical clinical signs of humeral fracture that were previously reported (Rakestraw et al., 1991) in cattle and horses. In close examination, the presence of swelling at the shoulder region, which was hot and painful. In addition, crepitating sound was detected by manipulation of the affected limb. Passive abduction and adduction of the affected limb were increased over the possible limits. In necropsy examination of the fractured humerus, this study found that the fracture lines were oblique or spiral and mostly found at the middle third of the shaft and sometimes extended to the distal third.

Blood samples were collected from 45 adult female Egyptian buffalos at the Menoufia governorate, Egypt. The animals were 5-15 years of age and 500- 650 kg body weight. 15 heavily pregnant buffalos in the dry period with humeral fracture (group A). 15 clinically normal heavily pregnant buffalos in the dry period (group B). 15 clinically normal (control group) non-pregnant mature females (group C). From the history, all animals were collected from different places and they were fed a ration composed of green fodders during the day and one kg concentrate at night.

Biochemical analysis

Samples of venous blood were obtained by puncturing the jugular vein. After blood clotting, samples were centrifuged at 3000 rpm for 10 minutes and the supernatants were centrifuged again at 3000 rpm for 10 minutes at room temperature. The harvested blood serum was stored at -20 $^{\circ}$C until analyses.

Biochemical analyses of total Blood serum Calcium (Ca), inorganic Phosphorus (P) and Magnesium (Mg) concentrations as well as the blood glucose level, and the activity of total alkaline phosphatase (ALP), calcitonin and Parathyroid (PTH) hormones were determined by the spectrophotometric method using commercially available test kits supplied by Biomed diagnostics (Germany).

Anatomical and radiological studies

Fifty specimens (25 from right and 25 from left humerus) were collected from the slaughter house at Menoufia governorate, Egypt. Animals were 5-15 years of age and 500-6500 kg body weight at the time of slaughtering. Gross and radiological examinations of the collected specimens were first performed by naked eye examination and then by using X-ray (*Siemens* unit) and CT scanning (Toshiba CT scan unit) for evaluation of the anatomical characters of them.

Mechanical bending test

The collected specimens were subjected to mechanical bending test to examine the load bearing capacity of them. The test was performed at the department of Civil Engineering, Faculty of Engineering, Menoufia University, Egypt by using mechanical bending test apparatus **(**ELE, international, USA made**)**. In the test, a vertical force was applied by the apparatus onto the long axis of the bone. The minimum and the maximum weight bearing capacity of each specimen were calculated by the apparatus at the first occurrence of the micro fracture incidence until the complete fracture of the bone respectively.

Statistical Analysis

The Data was statistically analyzed using SPSS version 15.0. Software (SPSS Inc., USA). Basic descriptive statistics (mean and standard deviation was calculated).

RESULTS

The biochemical analysis

The serum (Table 1) showed that calcium, magnesium, glucose and calcitonin were significantly lower ($P<0.01$) in the group A than in the other groups (B and C). Moreover, ALP and PTH in the group A were significantly higher ($P<0.01$) than the other groups. In addition, we found that there are no changes in serum Inorganic Phosphate (IP) between the three groups.

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The anatomical and radiological findings

The harvested humerus revealed that the shaft of the humerus is cylindrical cranio-caudally, which is slightly constricted at the middle (Figure.1). We found also, that the left humerus is slightly longer than the right one in all examined samples (Figures 2 and 3, Table 2). In comparing the right with the left humerus, we found that the outer diameter of the shaft is nearly similar between the right and left humerus at the proximal and distal thirds respectively (Figures 4 and 8, Table 2). On the other hand, we found that the outer diameter of the shaft at the middle third of the left humerus was smaller than the right one in all examined specimens (Figure 5 and Table 2). We also, found that the cortical thickness was greater in the right humerus than the left at the middle and distal thirds of the shaft (Figure 6: Figure 9 and Table 2). By measuring the diameter of the medullary canal, we found that, it was smaller (narrower) in the right humerus than the left one at the middle and the distal thirds of the bone shaft (Figures 7- 10; Table 2).

The mechanical bending test

It revealed that the weight bearing capacity of right humerus was greater than the left one in all of the examined specimens (Table 2).

Table 1. Biochemical Parameters of adult buffalos with and without humeral fracture.

Biochemical Parameters	GROUP (A) (With fracture) (N=15)	GROUP (B) (without fracture) (N=5)	GROUP (C) (Control) (N=5)
Ca(mmol/l)	1.02 ± 0.03^{b}	1.75 ± 0.02^{a}	2.01 ± 0.023^{a}
Mg(mmol/l)	0.88 ± 0.01^{b}	1.23 ± 0.03^{a}	1.33 ± 0.02^{a}
iP (mmol/l)	1.99 ± 0.031^{a}	1.87 ± 0.02^{a}	2.01 ± 0.01^{a}
ALP (u/l)	89.44 ± 0.05^{a}	54.22 ± 0.04^{b}	53.31 ± 0.02^{b}
Glucose (mmol/l)	2.91 ± 0.02^{b}	3.88 ± 0.03^{a}	3.94 ± 0.23^{a}
Calcitonin (ng/ml)	15.13 ± 0.04^{b}	20.18 ± 0.15^{a}	22.54 ± 0.04^{a}
PTH (ng/ml)	2.25 ± 0.03^{a}	1.55 ± 0.34^{b}	1.23 ± 0.02^{b}

Values in the same raw with different superscript letters are significantly different.

Table 2. The average measurements and weight bearing capacity of the right and left humerus of adult buffalos

	Computed Tomography										Bending force		
	Length	Outer diameter (shaft)			Width of medulla			Thickness of cortex			Mini	Max	Average
		Proximal	Middle	Distal	Proximal	Middle	Distal	Proximal	Middle	Distal			
Right	30.18	68.90	39.40	45.25	60.00	21.25	33.45	4.88	8.82	10.18	690	1660	1175
Left	31.10	69.05	37.20	45.40	56.50	22.70	36.55	5.00	7.43	9.55	530	1620	1075

Figure 1. It shows the shaft of the humerus is cylindrical cranio-caudally and slightly constricted at the middle of the bone on a Lateral view of left (L) and right (R) humerus using X ray

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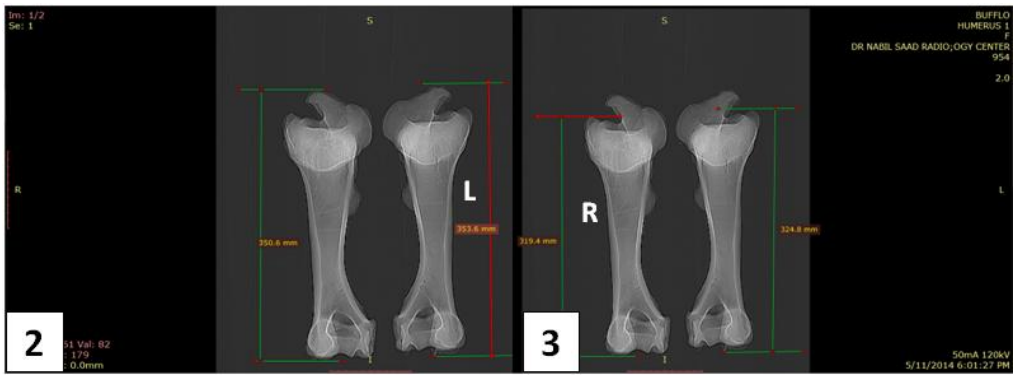

Figures 2 and 3. The left humerus is slightly longer than the right one on a cranial view of right (R) and left (L) humerus using CT

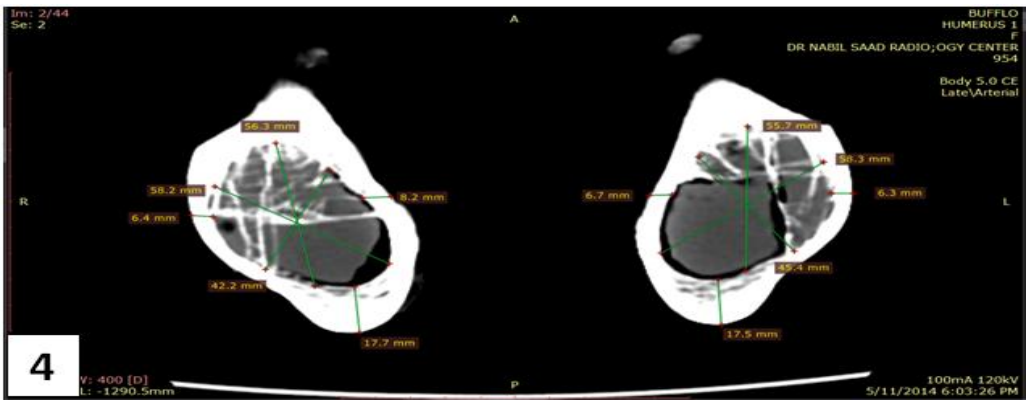

Figure 4. Cross section of the proximal extremities of the Right (R) and Left (L) humerus using CT, to show the medullary canal diameters and the cortical thickness.

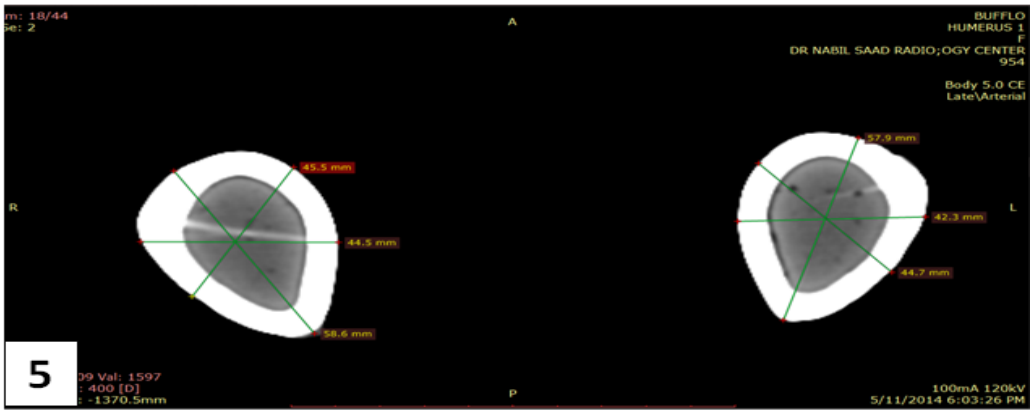

Figure 5. Cross section of the middle third of the Right (R) and Left (L) humerus using CT, to show the outer diameter of the shaft

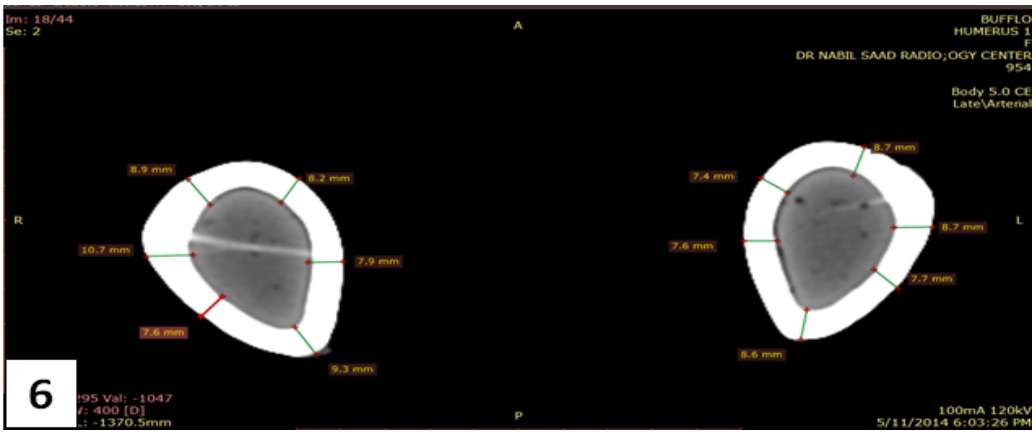

Figure 6. Cross section of the middle third of the Right (R) and Left (L) humerus using CT, to show the thickness of the cortex.

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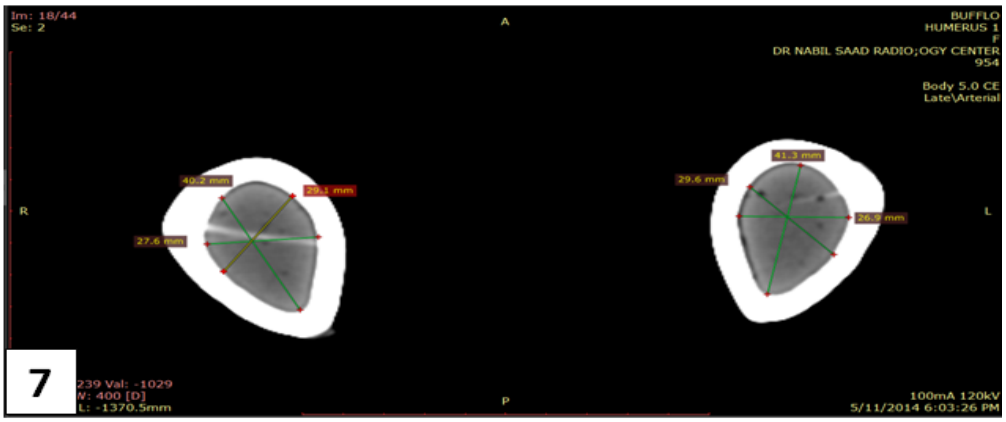

Figure 7. Cross section of the middle third of the Right (R) and Left (L) humerus using CT, to show the diameters of the medullary cavity.

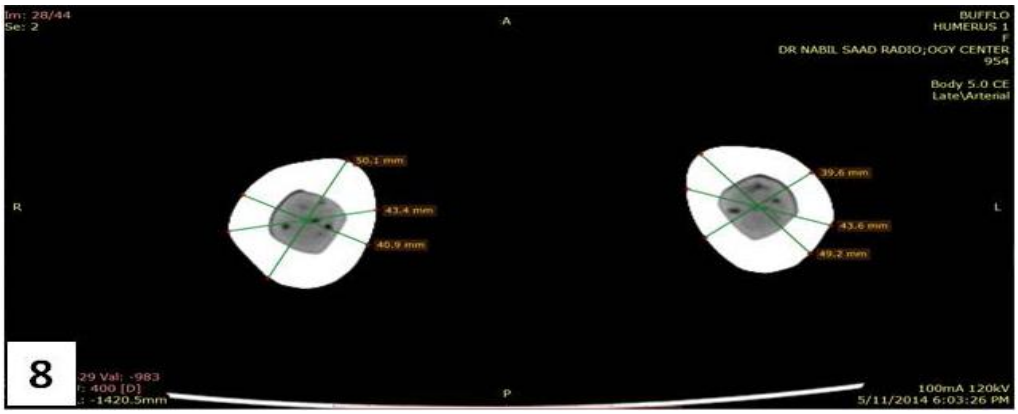

Figure 8. Cross section of the distal third of the Right (R) and left (L) humerus using CT to show the outer diameters of the shaft.

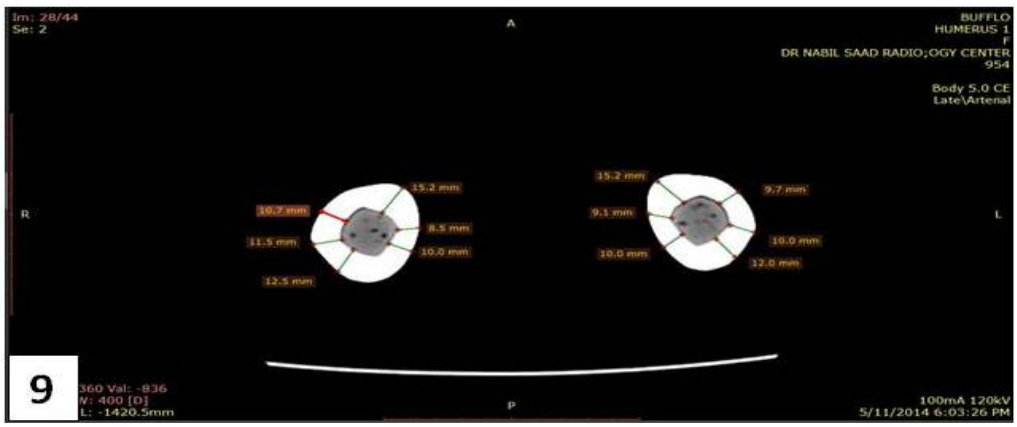

Figure 9. Cross section of the distal third of the Right (R) and Left (L) humerus using CT to show the diameters of the cortex.

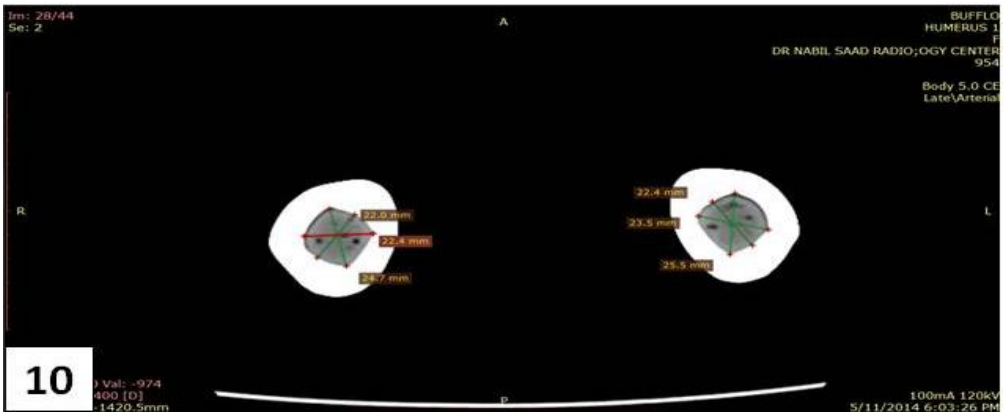

Figure 10. Cross section of the distal third of the Right (R) and Left (L) humerus using CT to show the diameters of the medullary cavity.

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DISCUSSION

According to our knowledge, this is the first report, which highlights the possible predisposing factors of humeral fracture in mature Egyptian buffalos especially the heavily pregnant ones. Fracture of long bones in large animals constitutes a major problem in our field due to the difficulty of treatment as well as the great economic losses that result from culling and slaughtering of the animal with the subsequent loss of the offspring and milk production.

In our locality, we observed that in most cases of long bone fracture in pregnant buffalos were either, sent to slaughter house directly or shortly after the onset of fracture out of fear of the subsequent complications or confined to a stall rest with conservative treatment until spontaneous healing takes place. Although, the owner saved the fetus in the later condition, economic losses occur from recumbency of the animal for a long period which, leads to loss of the animal body weight and skin ulceration. Moreover, conservative treatment of long bone fracture in large animals is time consuming and usually accompanied with complications resulting from imperfect healing as decreased chances of a favorable outcome (Rakestraw et al., 1991).

The goal of present study to determine the possible predisposing causes of humeral fracture especially the left one in heavy pregnant Egyptian buffalos, in order to take the possible prophylactic measures during this critical period and to reduce the economic losses from this problem, especially with the difficulty of treatment under the field condition.

The biochemical analysis of the serum samples revealed that the serum calcium was significantly lower in group A(Dry pregnant buffalos with humeral fracture) than other groups. It was our assumption that the decrease of serum calcium results from the high demand of the fetus in this critical period of pregnancy. Another contributing factor is the restricted feeding of the animals by the owners.

The serum magnesium level was significantly lower in-group A than in other groups while, the level of the parathyroid hormone was significantly higher in the same group. This may be attributed to the intimate inverse relationship between the activities of the parathyroid hormone and the magnesium balance (Mahaffey et al., 1972; Larsen et al, 2001; Goff, 2008). There were no changes in serum inorganic phosphate (IP) between the three groups. The ALP was significantly higher in group A than in the other groups. These results were in accordance with (Stari and Zadnik, 2010). The serum glucose level was significantly lower in group A than in other groups. This is may be attributed to the restricted feeding or to the effect of the hypocalcaemia. Oxalates are reported to have an irreversible effect on energy metabolism and plasma glucose level (Knight and Walter, 2003; Stari and Zadnik, 2010). The serum calcitonin level was significantly low in group A than in other groups, this may be attributed to the restricted food intake especially with low calcium level in the diet. The dropping of the serum calcitonin level together with the increased activities of the parathyroid hormones may result in the suppression of osteoblasts activities and stimulate osteolysis. In the long run, this may lead to fibrous osteodystrophy and decalcification of the bones making them soft and fragile (Bednarek et al., 2000 and Lukasz and Adam, 2005). From the aforementioned data, it can concluded that the increased demands of nutrients by the rapidly developing fetus during this critical period together, with the improper feeding by the owner greatly affected the bone metabolism of the mother and render them fragile and liable to fracture with the least force of trauma or stress.

The anatomical characteristics as well as, the outer and inner protection of the humerus make its fracture the least common type in-between long bone fractures in large animals (Markel et al., 1988; Rakestraw, 1996; Ferguson, 1997 and Arican, 2014). On the contrary, we found that fracture of the humerus is the most common type (about 46%) of long bone fractures in mature buffalos (especially the heavily pregnant ones). We suggested that Although the humerus is heavily protected from the lateral and medial aspects,, its inclined position in the animal's body makes it liable to excessive stress more than other long bones. This inclination of the humerus focuses the vertical forces (originating from the weight of the animal body) on the loge axis rather than the vertical axis of the bone.

From the gross and radiological (x-rays and CT) examination of both the right and left humerus of the buffalos we found that, the left humerus is slightly thinner than the right one at the middle third. By comparing the CT measurements of the cortical thickness and the diameter of medullary canal between the right and the left humerus, it can be concluded that there is an inverse relationship between the width of the medullary canal and the cortical thickness. Theoretically, from the aforementioned data, we can state that, the middle third is the weakest part of the bone shaft as well, as the left humerus is slightly weaker than the right one. This was confirmed by the mechanical bending test, in which we found that the weight bearing capacity of the left humerus is lower than the right one also fracture of the bone usually occurs at the middle third after application of the vertical forces.

The gross and CT measurements of the collected specimens revealed that the left humerus is slightly longer than the right ones. We suppose that the difference in the length between the right and left humerus may result in changing of the point of the weight-bearing center between both of them. This means that the point of weight bearing center moves slightly to the caudal (to the weaker part of the bone) aspect of the bone in the left humerus compared with the right one, which subjected it to more stress than the right one. From the aforementioned data, it can be concluded that the

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anatomical properties of the left humerus make it more liable to fracture (nearly 36.4% of all long bone fractures and 79% of the humeral fractures in pregnant buffalos) than the right one with stress.

CONCLUSION

Finally, it concluded that fractures of the left humerus in mature Egyptian buffalos are related to anatomical and metabolic predisposing factors, which interact with each other making the bone liable to fracture with minimum force of stress. During this critical period, the pregnant buffalos require careful management and handling as well as, it should be supplied with balanced ration containing all of the essential elements required for the rapidly developing fetus.

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