QUANTIFICATION OF TRACTION TO DELIVER THE BUFFALO CALF DURING FORCED CALVING AND ITS INFLUENCE ON BLOOD GAS AND ACID-BASE PARAMETERS

S. PRABHAKAR[1*], A. K. SINGH[2], P. S. BRAR[3] AND TARUNBIR SINGH[4]

Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana – 141 004

Received : 16.08.2011 Accepted : 16.11.2012

ABSTRACT

Calculation and measurement of manual traction was recorded during 21 extractions in buffalo dystocias categorized under mild assistance (Mi A), moderate assistance (Mo A) and forced assistance (Fo A) groups (n = 7; each). The blood samples were taken from the jugular venipuncture and the acid-base status of buffalo calves delivered through manipulation and forced extraction was studied over a period of five hours immediately after calving. The influence of the number of pulls, maximum force of traction and relative force of traction upon the peri-natal blood gas and acid-base values, and the vitality of the calves were investigated. It appeared that calves delivered with minimum, moderate and forced assistance exhibited a descending trend in parity (5.9 ± 0.3, 3.6 ± 0.2 and 1.3 ± 0.2, respectively). The time taken to deliver the fetus was significantly ($P < 0.05$) less in Mi A (4.1 ± 1.3 minutes) than in Mo A (7.9 ± 1.1 minutes) and Fo A (12.3 ± 1.4 minutes) groups. This was positively correlated with the number of pulls and number of assistants involved in pulling, thereby signifying the impact of parity on the above-mentioned parameters. Similarly, both maximum force of traction and relative force of traction were significantly ($P < 0.05$) lesser in Mi A group (1323.8 ± 6.2 Newton and 42.3 ± 2.2 Newton) as compared to their counterparts (2752.5 ± 7.3 Newton and 84.6 ± 3.5 Newton in Mo A; 4246.8 ± 9.1 Newton and 127.9 ± 5.1 Newton in Fo A). A significant ($P < 0.05$) decreasing trend was also observed at the level of internal pelvic area (380.9 ± 10.9 cm^2 vs 298.2 ± 12.3 cm^2 vs 216.4 ± 9.2 cm^2) and external pelvic area (652.1± 14.7 cm^2 vs 558.3 ± 12.1 cm^2 vs 497.6 ± 10.5 cm^2) in the Mi A , Mo A and Fo A groups, respectively. The calves delivered by means of minimum assistance showed substantial, metabolic acidosis for about 1 h. Metabolic acidosis was severe in the calves which were delivered by moderate and forced extractions that persisted for nearly 2-3 h. Any change in the acid-base status of the calf during extraction was evidently correlated with the number of pulls, time to deliver the fetus and the force of traction. It is shown that in complicated cases, the traction needs to be interrupted repeatedly, to give the calf the opportunity to breathe.

Key words: Acid-base profile, Buffalo, Calving, Traction

In bovine dystocias, traction is often applied to deliver the calf. Such assistance can be performed by means of manual or mechanical traction with adequate obstetrical techniques (Schuijt and Ball, 1980). Traction may cause several changes in the calf. On an average, powerful traction causes a greater increase of respiratory-metabolic acidosis in calves compared to normal delivery. The mean PCO_2 was significantly higher in calves delivered by powerful extraction than in those born following normal extraction (Massip, 1980). Excessive traction during deliveries is the most important cause of trauma in the newborn calf (Schuijt, 1990).

Present Address: [1*]Controller of Examinations, GADVASU, Ludhiana, E-mail: sp1962@yahoo.com
[2]Assistant Professor (Corresponding author), Department of Veterinary Gynaecology and Obstetrics, GADVASU, Ludhiana, E-mail: sp1962@yahoo.com
[3]Professor-cum-Head, Department of Veterinary Gynaecology and Obstetrics, COVS, GADVASU, Ludhiana, E-mail: parkashbrar@gmail.com
[4]Assistant Scientist, Department of Veterinary Surgery and Radiology, COVS, GADVASU, Ludhiana, E-mail: tarunbir@gmail.com

The force of traction is classified on the basis of the mean pulling power of either two or more persons (Hoyer *et al.,* 1990). For mild extraction, the force of traction should be equal to the mean pulling power of two men (Schuijt, 1997). For moderate extraction the force is greater than two, but less than the mean pulling power of four men (Schuijt and Ball, 1986). For excessive extraction, the force is even greater than the mean pulling power of four men (Schuh and Killeen, 1988). However, the estimation of the force of traction is very subjective. The aim of the present study was to make objective paper recordings of traction during buffalo obstetrical extractions, inorder to document and obtain more insight into the way, and the moments upon which, manual traction is applied during deliveries as well as to investigate the influence of quantified characteristics of manual traction on the blood gas and acid-base values and the vitality of the individual calf.

The study included equal number of calves in each group delivered with mild assistance (Mi A; n = 7), moderate assistance (Mo A; n = 7) and forced assistance (Fo A; n = 7) following correction of malpresentation and traction in normal anterior presentation during lateral recumbency of the dams. Dystociac buffaloes had been in labor for 4 to 8 hours. The calves were delivered from healthy Murrah buffalo heifers at term at the university clinic. Various parameters viz. number of pulls (NP), time to deliver the fetus, number of assistants involved in pulling along with the main gynaecologist, maximum force of traction (MFT), relative force of traction (RFT), weight of fetus, circumference of head, circumference of pastern, heart girth, lumber girth, crown-rump length (CRL) internal pelvic area (IPA) and external pelvic area (EPA) were determined (Dhaliwal, 1979). While the time to deliver the fetus was referred to the time from the start of traction until the calf was born, NP included the pulling efforts applied during the process of delivery of calf. The MFT was the highest measured force of pulls during an extraction, where as the RFT was reckoned as the force of traction per kg body weight of the calf, calculated on the basis of the maximum force. Both MFT and RFT were estimated based on the mathematical expression given below:

$$MFT = m_1 X a$$

Where m_1 is mass of the fetus and a is acceleration (9.8 m/s2).

$$RFT = \frac{m_1 X a}{m_2}$$

Where m_1 is mass of the fetus, m_2 is total mass of all the assistants and 'a' is acceleration (9.8 m/s^2).

The CRL was taken into account as the distance from the shoulder of the calf to the lumber region. The IPA was calculated on the basis of an equation as given below:

$$IPA = A X B$$

Where A is the transverse diameter of pelvic inlet (distance between right and left iliac bones) and B is the vertical diameter of pelvic inlet (distance between sacrum and pubis)

Similarly, EPA was calculated on the basis of quadratic equation as given below:

$$EPA = 1.22a X 1.3b$$

Where 1.22 and 1.3 are constants, a is the transverse diameter of pelvic outlet and b is the vertical diameter of pelvic outlet. They are further calculated as given below:

$$a = \frac{\text{Distance between hook bones + Distance between pin bones}}{4}$$

b = Distance between point of croup and point of hip joint X 3/4

Blood samples (2 ml) were taken by the standard method from jugular vein puncture, with the calves in lateral recumbency, under anaerobic conditions immediately at the time of birth and subsequently at 1, 2, 3, 4 and 5 hours of life in heparinized vials (10 IU heparin/ml blood). The blood samples were capped and placed on ice immediately so as to avoid alteration in blood gas tension. Actual blood pH, partial pressure of carbon dioxide (pCO_2), partial pressure of oxygen (pO_2), actual bicarbonate (HCO_3^-) and actual base excess (ABE) were determined by blood gas analyzer (Radiometer Medical APS-77, Copenhagen) within one hour after sampling at 37ºC. The values for pH and base excess were taken as the criteria for recovery from acidemia. Follow-up of the vitality of the calves during the first few weeks of life was based on clinical observation and telephone inquiries.

The data were analyzed by the use of the Statistical Package for Social Sciences (SPSS 16.0, Chicago, IL; 2003) system for windows. sionse parameters and The differences between Mi A, Mo A and Se A groups for acid-base imbalances were tested using 2 x 2 analysis of variance (ANOVA) with significant interaction at 5% level. The significant interactions were tested using Duncan's multiple range test. Differences in mean ($\overline{X}$ ± SEM) blood gas changes in the three groups with unequal variances were tested with Chisquare tests of independence subjected to Bonferroni correction as per the methods described previously (Zar, 2008).

All calves survived 7 days of life. Observations revealed that calves delivered with forced assistance took significantly ($P < 0.05$) longer duration for delivery as compared to their counterparts (Table 1). They recorded significantly ($P < 0.05$) more number of pulls (NP), time to deliver the fetus, maximum force of traction (MFT), relative force of traction (RFT), internal pelvic area (IPA) and external pelvic area (EPA). Even the time taken to deliver the fetus was significantly ($P < 0.05$) more in Mo A than in Mi A group. With increase in parity, dilatation of cervix and birth canal is expected, thereby reducing the quantum of force as well as time in the expulsion of fetus (Schuijt and Ball, 1986). In the current investigation a more time taken to deliver the fetus resulting in more application of persons along with more number of pulls could merely be a parity difference. Estimation of force of traction by assistants might be an influencing factor with regard to the amount of force applied. To minimize the error, steps were taken to deliver the fetus wisth assistants having nearly similar bodyweight with a precision of 5 kg. Schuijt, (1990) demonstrated a ± 5 kg variation in bodyweight of assistant is justified to deliver vital calves. Not surprisingly, both IPA and EPA were also significantly ($P < 0.05$) more in Se A group as compared to their respective counterparts which could be closely related to parity. If the pelvic area is less the chances of buffalo to suffer from dystocia is more. Therefore, the overall difference could be attributed to the variation in parity. The other remaining parameters like weight of fetus, circumference of head, circumference of pastern, heart girth, lumber girth and CRL, although of associated significance, however, exhibited a non-significant ($P > 0.05$) difference in all the groups. Any disparity in these parameters could affect the force applied over and above the duration of extraction in the process of delivery. The chances of dystocia can be predicted from ratio between the pelvic area and weight of the fetus. As the ratio of pelvic area to calf weight increases, the chances of dystocia increases (Schuijt and Ball, 1980).

The highest significant positive correlations were found between the maximum and relative force of traction and the individual changes in pH, PCO_2, PO_2 and actual base excess in the calves during delivery with moderate and forced assistance, indicating stress in them (Table 2). The relationship between acid-base profile and traction parameters according to the type of delivery, as found in the present study agrees with the findings of Szenci *et al.* (1988). The correlation between the number of pulls and the changes in acid-base values were also high for Mo A and Fo A groups as compared to their counterparts, but it must be realized that the number of pulls was highly correlated with the duration of extraction as well as weight of persons. However, the weight of the persons was almost similar in the current set of experiment. Amongst different parameters, the level of significance was most pronounced for MFT and RFT in all Mo A and Fo A groups. However, the positive correlation of other traction parameters with acid-base value rendered their contribution toward neonatal stress as well especially in Mo A and Fo A groups. This means that MFT, RFT and NP had a high diagnostic value and can be obtained within a practicable time. A negative correlation existed between Mi A and above-mentioned traction parameters. The strong correlation between traction parameters and acid-base profile, as found in the present study, may be explained by type of delivery and the physical efforts applied in the process of calving which may all influence the recovery from stress and hypoxia during the time that the calf tries to stand.

The acid-base changes in blood of all the calves are shown in table 3. Any fluctuation in the blood gas parameters seemed to indicate the dynamic alterations occurring due to impending calving.

Blood pH was significantly ($P < 0.05$) lower in Se A compared to Mo A and Mi A calves. Immediately after delivery, a decrease in pH was observed in Fo A calves which increased gradually over the period after calving especially after 4 h whereby the fetuses also tend to become stable. Comparatively, the blood pH took less time to attain stability in Mo A than in Fo A groups. In Mi A calves, blood pH was fairly constant and within the normal limits throughout the sampling period especially 1 h after calving suggesting no clinical manifestation of changed acid-base balance owing to serious degenerative tissue changes that alter the blood pH (Glowisching and Schlerka, 1980). Marked changes in pH reflect acute cellular injury (Zanker *et al.,* 2001). This stands true for the calves delivered with forced assistance which might have resulted in mycote injury of skeletal muscle due to manipulations applied in the process of delivery of fetus in the present study. Blood pH is determined by the ratio between bicarbonate and pCO_2. A decrease in the pH reflects increase in the hydrogen ion concentration that results in acidosis which persisted for nearly two to three hours in Fo A calves. This acidosis appeared more metabolic as appreciable increase in pCO_2 was observed. Neonatal calves delivered forcefully develop metabolic acidosis owing to change in the pH (Rhee *et al.,* 1993). Moreover, injurious effect of traction also corresponded to decrease in the pH through tissue hypoxia immediately after delivery as observed in the current investigation (Owens and Edey, 1985).

A reversible trend was observed for both the parameters in the three groups. While the concentration of pCO_2 was significantly ($P < 0.05$) highest in Fo A calves, followed by Mo A and then Mi A calves, reverse was true for the pO_2. Large amount of CO_2 is produced by oxidative metabolism. This CO_2 combines with water in the blood-stream resulting in formation of carbonic acid leading to increase in the secretion of H^+ and decrease in the pH (Carlson and Bruss, 2008). In Fo A group, the pCO_2 values were stable after 4 – 5 h indicating the struggling period of calves for survivability, which was longer than in the calves delivered with moderate and mild assistance. The net effect of pCO_2 especially in Se A calves resulted in hyperventilation as a result of increased physiological dead space owing to stress and pain at the time of delivery. Hyperventilation arises as the venous pCO_2 rises above 55 mm Hg (Constable, 2000). This can be corroborated with increase in pCO_2 levels immediately after delivery, may be due to over stimulation of apneustic centre of medulla oblongata. The compensating response is mediated through respiratory system, which within limits, alters the pCO_2 so as to partially restore the pH toward normal (de Morais, 1992).

As mentioned earlier, the oxygen tensions in Mi A, Mo A and Fo A calves exhibited a much significant ($P < 0.05$) change. Increase in pO_2 over the period of time in the three groups was due to hypercapnea (Berchtold *et al.,* 2001). The values in Fo A group displayed a sharp rise after 4 h indicating the compensatory response towards physiological levels. Hypercapnea occurs as the arterial pO_2 falls below 40 mm Hg (Roussel *et al.,* 1998) which appeared true for Fo A calves immediately after delivery.

The metabolic component of acid-base balance is indicated by the bicarbonate concentration. Bicarbonate is usually estimated by determination of the "CO_3^- content" or "total CO_2" of blood samples since it accounts for approximately 95% of the measured total CO_2, and thus the total CO_2 provides a measure of metabolic changes in acid-base balance. In the present study, alterations in HCO_3^- suggested compensatory efforts. The values were significantly ($P < 0.05$) higher in Mi A compared to other two groups. Five hours after calving, the mean values of bicarbonate had improved as the animals were in the process of homeostasis. The bicarbonate measured is decreased in metabolic acidosis. These measurements may indicate the metabolic acid-base status. Any change in carbon dioxide difference could reflect changes in bicarbonate delivery to the tissue (Szenci and Taverne, 1988).

The base excess or deficit indicates the sum of all the buffer anions in blood under standardized conditions. A negative value is generally taken as an indication of the deviation of bicarbonate from normal which is commonly found in animals suffering from metabolic acidosis (Carlson and Bruss, 2008). In the present study, a negative value in Fo A calves was observed that indicated acidosis in the blood. Even a negative value immediately at calving indicated a mild degree of acidosis even in the calves delivered with moderate and mild assistance which tend to get stabilized, thereafter. Therefore, it can be concluded that base values of blood at the time of birth in calves delivered after traction can be of diagnostic significance.

It is thus, probable that buffalo calves delivered following dyctocia have metabolic acidosis which stabilizes over a period of time. Consequently, a proper guideline is justified to extract calves with optimum force of traction. During the obstetrical examination, veterinarians should practice their ability to judge the type and the weight of the unborn calf. Close attention for number of pulls and force of traction is always needed because it is quantitative information which can give us better understanding of the quick and timely delivery of fetus. It is, therefore, recommended to monitor traction parameters in conjunction with the acid-base profile as a matter of intensive and critical care.

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