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ARTICLE

Pregnancy Related Sequential Changes of the Foetal Fluids And Foetal Positioning in Sahel Goats

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SUMMARY

A study on pregnancy related, and sequential, changes in the Sahel goat foetal fluid and foetal disposition at various stages of pregnancy was undertaken to provide basic data in these aspects of gestation in goats. Twenty five pregnant Sahel goats of known pregnancy stages, and managed under controlled conditions were used for this study. Thirty three foetuses were obtained from these pregnancies of which 18 (54.5%) were females and 15 (45.5%) were males; 17 (68%) had single foetus, 8(32%) twin foetuses. Transuterine migration was 23.53% in single and 37.5% in twin pregnancies. **The foetal fluid changes showed that the volume of the amniotic fluid increased from day 28 (21.0 ± 0.33 ml) of gestation to day 112 (500 ± 15.81 ml) and then dropped onwards up to day 140 (220 ± 10.80 ml). Conversely, the allantoic fluid (25.5 ± 2.00 ml at 28d to 735.0 ± 17.08 ml at 140d) continued to increase in volume throughout pregnancy. The volume, colour, consistency and pH changed with increase in gestation period. The specific gravity of the amniotic fluid increased with advancing pregnancy. The results of this study suggest that urine enters first into amniotic cavity and then into the allantoic cavity by 112d pregnancy in goats. The present study also provided a guide to be used in assessing the volume and consistencies of foetal fluids in goats and the intrauterine positioning of foetuses as a measure to monitor and manage pregnant Sahel does.**

KEY WORDS: fluids, foetal, position, Sahel goat, sequential.

INTRODUCTION

Sahel goats are highly fertile and mainly used for the production of meat and milk (Egwu *et al*, 1995; Chibuzo *et al*, 1997). Precise information regarding the activity of the ovaries, incidence of twin and triplet pregnancies, embryonic loss and trans-uterine migration are useful indices to assess the pattern of reproduction capacity in the species. Lyngset (1971) studied reproduction of Norwegian goats and reported that colour and consistency of the foetal fluid changed with the stages of pregnancy. Rahaman *et al,* (1977) reported the incidence of single (20.1%), twin (13.4%), triplet (25.5%) and quadruplet (13.4%) pregnancies in Black Bengal goats. Other similar studies were carried on Iraqi goats (Alwan *et al*, 1993). Information available from previous studies on Nigerian goats is scanty (Osuagwuh and Aire, 1986; Waziri *et al*, 2002).

Information on changes in foetal fluids and in foetal disposition during known stages of pregnancy in Sahel goats is currently not available. The purpose of the study was therefore, to determine the development of foetal fluid and foetal disposition (location and orientation) at various stages of pregnancy. Such information is expected to guide in monitoring and managing pregnant Sahel goats.

MATERIALS AND METHODS

Twenty-five adult Sahel does and two Sahel bucks were used in this study. The animals were used within the limits of the International guiding principles for biomedical research involving animals (Anonymous, 1985)

Their live-weights ranged from 14 to 25kg and the parity was not known. The animals (does) were synchronised with prostaglandin ($PGF_{2\alpha}$) and those that came into heat were mated with a healthy and sexually active Sahel buck. The service was repeated if the doe still remained on heat the following day. The service dates were recorded. Non-return to service was considered as an indication for conception. The uteri were recovered following a humane salvage of the animals by exsanguinations under barbiturate anaesthesia at a known age of gestation. The foetuses were harvested on days 28, 56, 84, 112 and 140 of gestation. Each group in the above five stages consisted of five does.

Five pregnant does were salvaged at days 28, 56, 84 and 112 of gestation, and four at day 140 of gestation. One was allowed to deliver. The pregnant uteri were immediately and carefully dissected out and examined as follows:

- The uterine wall of each pregnant horn was cut out and the underlying foetal cotyledons were separated from maternal caruncles to display amniotic and allantoic compartments. Fluid from each compartment was collected using a 50 ml syringe with an 18 G needle, and its volume measured. The pH was determined using an electronic pH-meter (ph 96, WTW), colour and consistency of each amniotic and allantoic fluid sample were recorded.
- The location of foetus was also recorded and its crown-rump length (CRL) was measured from the forehead to the root of the tail.
- Each ovary was examined for number and position of corpora lutea. The right and left ovaries were dissected. The length of each ovary was determined as the maximal distance from pole-to-pole along an axis parallel to the ovarian mesenterial attachment. Width was measured as the greatest distance along an axis from attached border to free border, while thickness was measured as the greatest distance along an axis from surface to surface. Weight of both ovaries was obtained using an electric analytical balance (Mettler® Ch8606).

- The data were presented as mean $\pm$ SEM. The data was subjected to Analysis of Variance (ANOVA) using a statistical software package (Anonymous, 1998, GraphPad Software, Inc., San Diego California USA), and significant means where detected were separated by Turkeys-Kramer Multiple Comparison Test. What level of significance was acceptable? $P<0.05$ or $P<0.01$? (Both levels are acceptable. It only shows how highly statistically significant 5% or 1%, but I used $P<0.05$)

RESULTS

Table I shows the details of the Sahel does and uterine dimensions, cotyledonary size and number of placentomes at various stages of pregnancy in these animals. The weights of the does as well as the length of the uterine horns increased with advancing pregnancy. The variations of the Mean $\pm$ SEM in the body weight (kg), length (cm) of uterus, size (cm) of cotyledons, the inter-cotyledonary distance (cm) and number of placentomes at days 28, 56, 84, 112 and 140 of gestation are indicated in the table.

In general, there was significant difference ($P<0.05$) amongst the primary, secondary and tertiary cotyledons at later stages of pregnancy; there was increase in number of placentomes which were discernible as pregnancy progressed? (Not absolute increase in number, but increase in number of placentomes that can easily be distinguished by the eye i.e. discernible); inter-cotyledonary distance decreased; both right and left horns as well as the body appeared larger.

The trend of changes in the amount of foetal fluid, pH, specific gravity and C-R length is presented in Table II. The volume of allantoic and amniotic fluids increased with advancing gestation. At day 28 of gestation, both fluids were colourless and watery. At day 56 of gestation, both foetal fluids were still watery and clear. At day 84 the amniotic fluid became straw coloured and watery while, the allantoic fluid had some yellowish tinge or sparkle with watery consistency.

By day 112 of gestation, the amniotic fluid was darker and slimy, and became foamy on slight agitation while, the allantoic fluid was yellowish with brownish particles and had a watery consistency. At day 140 of gestation, the amniotic fluid was dark straw or amber coloured and still foam, and had a more viscous and slimy consistency while, the allantoic fluid was yellowish brown and turbid but still, had a watery consistency.

The consistency of allantoic fluid was thus watery in consistency throughout gestation and colour changed from colourless to yellow and turbid as pregnancy advanced. The amniotic fluid was watery until around day 84 of gestation and subsequently was mucoid and gelatinous while its colour changed from watery to amber or dark straw.

The change in trend of foetal fluid accumulation with age has been shown graphically in Figure 1. A sharp fall in the amount of amniotic fluid around day 112 to 140 from an initial increase from day 56 to 112, while the allantoic fluid had a gradual increase up to day 112 and followed by a sharp increase from then up to day 140. There was, however, a continuous increase in the total volume of the foetal fluids during the whole period of observation. The same interrelationship was seen between crown-rump lengths as regards the accumulation of foetal fluids during pregnancy (Figure 2).

The pH of both fluids gravitated from neutral towards acidity as pregnancy advanced. The specific gravity of the amniotic fluid showed a marginal change from 1.002 at 28d of gestation; 1.004 by 84d of gestation, and 1.005 at 140d of gestation. The specific gravity of allantoic fluid on the other hand remained constant at 1.0. The values for both fluids did not vary much from that of water.

In the 25 pregnant goats, a total of 33 foetuses were obtained of which 18 (54.5%) were females and 15 (45.5%) were males; 17 (68%) had single foetus, 8 (32%) twin foetuses and none (0%) had triplet. Four cases of the single pregnancies (23.53%) showed transuterine migration, three and one from right to left and vice versa, respectively How.? (Responded to question in the cover letter). In twin pregnancies 6 out of 16 foetuses (37.5%) showed transuterine migration, 2 and 4 from right to left and vice versa, respectively. How ? (Answered question in the cover letter). The location of the foetuses in the uterus is presented in Table III. At day 28 of gestation, and up to day 56, the foetuses were located in the gravid horn but their orientation was difficult to determine, because of the high mobility (floats) of the foetuses in the amnion. They could move easily around both longitudinal and transverse axes.

Of the 6 foetuses recovered at 84 days of gestation, three were in anterior longitudinal while the other three were in posterior longitudinal orientation. Their limbs were flexed. The long axis of the foetus aligned with the long axis of the uterine horn. At day 112 of gestation, five foetuses were anterior longitudinally presented while two were posterior longitudinally presented with flexed limbs. By 140 days of gestation, of the six foetuses recovered and one that kidded, five were anterior longitudinally presented while two (co-twin) were posterior longitudinally presented. Of the six foetuses, only one had extended limbs in the anterior presentation, except for the one that kidded.

The mean ($\pm$ SEM) dimensions and weight of ovaries in the pregnant goats are shown in Table IV. A total of 24 pairs of ovaries from pregnant genitalia were recovered. Thirteen and 15 of the ovaries had no CL on the right and left ovaries, respectively. Eleven and 9 of the ovaries had one or more CL, respectively. There was a significant ($P<0.05$) difference between the length, width, thickness and weight of the ovaries without CL and those with CL. However, there was no significant ($P>0.05$) difference in the said parameters between the values of the left and right ovaries with or without CL.

Table V shows the dimensions and weights of ovaries, uteri, foetuses and foetal membranes of pregnant Sahel goats at day 28, 56, 84, 112 and 140 of gestation. There was a steady increase in the mean weight of the uterus, weight of the foetus, and the mean length, width, thickness and weight of the right and left ovary as pregnancy advanced, respectively.

DISCUSSION

The body weights of the animals showed a steady increase from the time of purchase to the time of slaughter. The increase became statistically significant ($P<0.05$) when the animals attained 112 days of gestation. This could be attributed to better care, nutrition and the advancing pregnancy. Adequate nutrition, especially in the tropics, is regarded as the ultimate regulator of reproduction (Freitas *et al*, 2004).

The present study showed that the pregnant horn was longer than the non pregnant one in all cases. The length of the uterine horns and the body measured in the present study were similar to those recorded by Das *et al,* (1982) who recorded a mean length (16.33 $\pm$ 0.20 cm and 16.88 $\pm$ 0.18 cm for right and left uterine horns, respectively) in female goats of Assam. The length varies with nature of pregnancy. The side with the foetus is longer due to the presence of the developing foetus.

In the present study, the mean sizes of the cotyledons were seen to increase as the pregnancy developed. The cotyledons were classified into primary (large), secondary (intermediate) and tertiary (small) with respect to their sizes. The difference in the sizes of the cotyledons became significant ($P<0.05$) as from day 112 of gestation. The larger cotyledons were seen in close proximity to the umbilical vessels and the smaller ones were mostly at the periphery. The observation is consistent with the reports of Latshaw (1987); and Arthur *et al,* (1998). The number of placentomes in the present study showed a steady increase in size as pregnancy advance. This may be attributed to the increasing foetal demands as pregnancy advances, thus necessitating the development of more placentomes. However, the inter-cotyledonary distance was observed to be decreasing as the pregnancy advanced. This could be associated with the increasing number of placentomes and the sizes of the cotyledons as the pregnancy advances; consequently, the cotyledons tend to be crowded.

Primary cotyledons are much larger with extensive area of attachment with its maternal counterpart which indicated that they have stronger union than the smaller ones. Anatomically, it could be predicted that whether it is under normal circumstances or in retained placenta, the smaller ones are likely to get detached earlier than the primaries due to early necrosis. This is an area which could be explored in further studies. Conversely, in cases involving toxicity, the primary cotyledonary attachments may suffer well before the smaller ones are affected (Waziri *et al*, 2009).

The observed ratio of single and twin pregnancies of 17:8 in this study is in conformity to the findings of Bhattacharya (1989); and Alwan *et al,* (1993) who reported a single-to-twin ratio of 77.5:22.5; 193:46:1, in Ardhi and Iraqi goats, respectively. The low incidence of twin pregnancy and lack of triplet pregnancy in this study is comparable to the previous reports of Bongso *et al,* (1979) and Alwan *et al,* (1993).

Occasionally, migration of embryo from one horn to the other has been reported in sheep (Arthur, 1956), swine (Jones, 1966), West African Dwarf goat (Osuagwuh and Aire, 1983) and Sahel goat (Waziri *et al*, 2002). In the present study, the incidence of transuterine migration was 23.53% in single and 37.5% in twin pregnancies. These findings agree with the previous reports of Alwan *et al,* (1993) who observed 37.8% in single and 19.6% in twin pregnancies, in Iraqi goats, and Waziri *et al,* (2002) who reported 15.87% and 29.26% in single and twin pregnancies in Sahel goats, respectively. In goats, the transuterine migration appears to be a natural phenomenon for even spacing of the developing ova in each horn, especially when more than one ovum is released from the same ovary. Factors which obviously have bearing on relation between ovulation and cornual distribution are the phenomenon of intercornual migration of embryos and embryonic deaths (Akpokodje *et al*, 1986).

The result of the foetal location in the right and left uterine horn is in agreement with the studies of Bongso *et al*, (1979), Osuagwuh and Aire, (1983) and Alwan *et al*, (1993). The observed foetal orientation and presentation across gestation in the present study is consistent with the observations of Osuagwuh and Aire (1983) in West African Dwarf goat. An interesting observation in this study is that up to 140^{th} day of gestation, except in one case the foetuses had flexed limbs. This suggests that extension of limbs occur immediately prior to parturition. Further studies should be conducted to determine the exact time when extension of the limbs occurs before parturition although there is likelihood that the extension occurs during the parturition process.

The foetal gestational age and the crown-rump length (CRL) measurements were directly correlated with the foetal fluid volumes. The volume, colour and consistency of the amniotic and allantoic fluids were similar to those observed by previous workers (Boyd, 1979; Bongso *et al*, 1979; Alwan *et al*, 1993, Arthur *et al*, 1998). In twin pregnancies, each foetus and its foetal compartment behaves like a single pregnancy with regard to foetal fluid volume and foetal formation. The specific gravity of the amniotic fluid increased as the pregnancy advanced. This could be attributed to the increasing viscosity of the amnion which is associated with the foetal mucous secretions (Latshaw, 1987) and probably reduction of the amniotic fluid as pregnancy approaches its final stage.

In the present study, the pH tended to become acidic as pregnancy advanced. This may be associated to a probable maternal metabolic situation which renders the dam vulnerable to the breakdown of the ketones and a build up of lactic acid as the pregnancy advanced due to the increasing foetal demand of energy. On the other hand, the foetus itself may be metabolizing some acidic waste products into its urine which is likely to enter into both amniotic and allantoic foetal fluids.

The mean dimensions and weights of the ovaries observed in this study are consistent with earlier reports (Lyngset, 1968; Alwan *et al.*, 1993; Waziri *et al*, 2002). The trend of increase in the mean weights of the pregnant uterus, foetus and foetal membranes as pregnancy advanced is consistent with the reports of Jainudeen and Hafez (1993); Arthur *et al,* (1998).

In conclusion, the present study indicated the occurrence of transuterine migration in Sahel goats. The volume, colour, consistency and pH changed with increase in gestation period. The specific gravity of the amniotic fluid also increased with advancing pregnancy. These changes could be used in monitoring and managing pregnancy changes in Sahel goats. The present study has thus provided a guide to be used in assessing the foetal fluid volume changes and their consistencies in Sahel goats.

TABLE I Mean ± SEM variations in the body weight (kg), length (cm) of uterus, size (cm) of cotyledons, inter-cotyledonary distance (cm) and number of placentomes. at 28, 56, 84, 112 & 140 days gestation of Sahel goats

Pregn	Age	Wt. at purch.	Wt at salvage..	Uterus (length)			Cotyledons LxW (cm)				No. of
(days)	(years)	(kg)	(kg)	Rt horn (cm)	Lt horn (cm)	body (cm)	Primary.	Second.	Tertiary	Int-coty/dist.	placentomes
28 (5)	1.8± 0.12	14.8± 0.58	15.9± 0.60	13.5± 1.18	13.9± 1.08	15.4± 0.35	2.1± 0.17	1.6± 0.27	0.9± 0.08	1.0± 0.12	71.4± 2.73
56 (5)	1.7± 0.02	21.0± 1.05	22.7± 0.97	14.6± 1.06	16.7± 0.22	18.3± 0.65	2.5± 0.16	1.3± 0.18	0.9± 0.09	1.1± 0.14	85.0± 4.47
84 (5)	2.0± 0.27	18.6± 0.87	21.2± 0.98	17.0± 1.60	20.8± 1.23	20.4± 0.32	4.4± 0.43	2.3± 0.17	0.9± 0.21	0.7± 0.13	94.6± 4.57
112 (5)	1.7± 0.20	16.2^{*} ± 1.16	25.4^{*} ± 1.01	17.2± 0.42	13.1± 1.39	21.3± 1.36	8.6^{a} ± 1.57	3.3^{b} ± 0.47	0.8^{c} ± 0.13	0.5± 0.05	95.4± 2.56
140 (4)	2.1± 0.24	18.0^{*} ± 1.18	27.7^{*} ± 0.43	20.8± 2.98	20.5± 2.67	21.8± 0.66	12.1^{a} ± 0.92	4.4^{b} ± 0.23	1.2^{c} ± 0.08	0.3± 0.02	94.8± 3.90

( ) Number in parenthesis represents the sample size
Values within rows with different superscripts (letters) differ significantly (P<0.05)
Values within rows with * superscript are different significantly (P<0.05)

TABLE II Variation in the amount of foetal fluid (ml), pH and Specific gravity with C-R length (cm) at 28, 56, 84, 112 & 140 days gestation of Sahel goats

Foetal age Wks (days)	C-R length (cm)	Total amount of fluid (ml) mean	Amniotic Fluid Volume (ml)	pH	Specific gravity	Allantoic Fluid Volume (ml)	pH	Specific gravity
4 (28)	3.12 ± 0.29*	46.5 (4)	21.0 ± 0.33	7.57 ± 0.09	1.002 ± 0.002	25.5 ± 2.00	6.81 ± 0.23	1.0 ± 0.0
8 (56)	10.79 ± 0.67	161.0 (5)	109.0 ± 5.83	7.57 ± 0.09	1.002 ± 0.002	52.0 ± 2.00	6.61 ± 0.16	1.0 ± 0.0
12 (84)	21.08 ± 0.79	532.0 (5)	408.0 ± 11.57	7.33 ± 0.11	1.004 ± 0.002	124.6 ± 6.41	6.90 ± 0.19	1.0 ± 0.0
16 (112)	29.45 ± 0.80	754.0 (5)	500.0 ± 15.81	5.81 ± 0.36	1.004 ± 0.003	254.0 ± 16.31	4.99 ± 0.28	1.0 ± 0.0
20 (140)	34.28 ± 0.47	955.0 (4)	220.0 ± 10.80	5.96 ± 0.34	1.005 ± 0.003	735.0 ± 17.08	5.89 ± 0.39	1.0 ± 0.0

* Mean ± SEM Figure in parenthesis represents the number of samples

TABLE III Location of foetuses in the right and left uterine horns

Single	17	68	9*	7*	17*	51.5
Twin	8	32	8	8	16	48.5
Triplet	0	0	0	0	0	0
Total	25	100	17*	15*	33	100

* One doe delivered a single foetus

TABLE IV Dimensions (cm) and weight (g) of ovaries in pregnant goats (Mean ± SEM)

Sample	No	Right ovary				No.	Left ovary			
		Length (cm)	Width (cm)	Thick. (cm)	Weight (g)		Length (cm)	Width (cm)	Thick. (cm)	Weight (g)
Total	24	1.61 ± 0.09	1.18 ± 0.06	0.59 ± 0.05	1.61 ± 0.17	24	1.65 ± 0.01	1.16 ± 0.04	0.63 ± 0.06	1.94 ± 0.16
Ovary without CL	13	1.32* ± 0.08	1.0 ± 0.08	0.46* ± 0.06	1.04* ± 0.08	15	1.38* ± 0.06	1.04* ± 0.05	0.44* ± 0.07	1.41* ± 0.08
Ovary with 1 or 2 CL	11	2.00* ± 0.01	1.29 ± 0.07	0.77* ± 0.02	2.36* ± 0.19	9	1.85* ± 0.13	1.26* ± 0.05	0.78* ± 0.08	2.33* ± 0.22

* Significant difference at $P<0.05$ between right or left ovaries with one or more CL., and the ovaries without CL.

TABLE V Dimension (cm) and weight (g) of ovaries, uterus, foetus(es) and foetal membranes in pregnant Sahel goats (Mean ± SEM)

Gest. (dys)	Wt. of preg uterus. (g)	Wt. of foetus (g)	Wt. of memb (g)	Right ovary (cm)				Left ovary (cm)			
				L	W	Th.	Wt	L	W	Th.	Wt
28	115.6 ± 22.3	25.2 ± 0.37	6.95 ± 0.29	1.32 ± 0.18	1.08 ± 0.06	0.68 ± 0.04	1.48 ± 0.17	1.20 ± 0.07	1.12 ± 0.04	0.32 ± 0.05	1.32 ± 0.11
56	711.3 ± 72.9	28.3 ± 1.45	291.2 ± 24.0	1.52 ± 0.12	1.02 ± 0.08	0.59 ± 0.10	1.68 ± 0.37	1.56 ± 0.09	1.17 ± 0.05	0.51 ± 0.09	1.96 ± 0.24
84	1406.4 ± 109	383.9 ± 67.1	572.5 ± 39.1	1.62 ± 0.14	1.31 ± 0.17	0.42 ± 0.83	2.60 ± 1.35	2.03 ± 0.25	1.25 ± 0.09	0.67 ± 0.11	2.22 ± 0.43
112	2704.4 ± 425	818.1 ± 50.9	692.9 ± 91.7	1.59 ± 0.32	1.17 ± 0.16	0.62 ± 0.10	1.76 ± 0.62	1.84 ± 0.16	1.17 ± 0.05	0.81 ± 0.11	2.14 ± 0.42
140	4150.3 ± 444	1148.6 ± 66.5	1000.0 ± 16.9	2.04 ± 0.18	1.32 ± 0.12	0.85 ± 0.06	2.03 ± 0.28	1.65 ± 0.12	1.08 ± 0.23	0.83 ± 0.16	1.37 ± 0.41

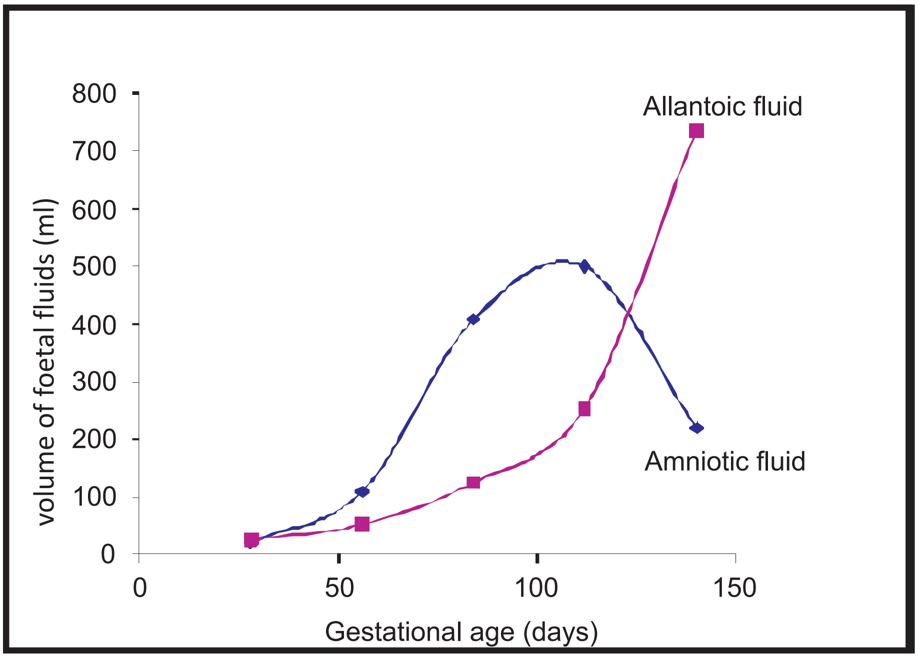

Fig. 1 Pattern of changes in foetal fluids volume with respect to age

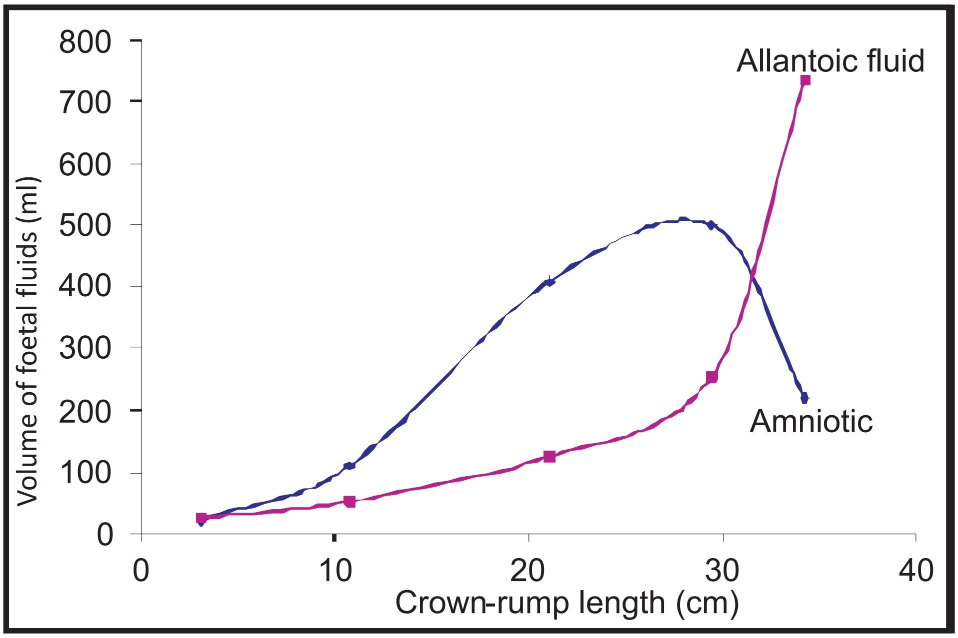

Fig. 2 Pattern of changes in foetal fluids volume with respect to crown- rump length

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