Salivary buffer effect in relation to late pregnancy and postpartum

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We studied the salivary pH, buffer effect (BE), and flow rates of unstimulated and paraffin-stimulated saliva of 8 women in their late pregnancy and postpartum. Salivary samples were collected about 1 month prior to and about 2 months after delivery. In non-pregnant control women, two paraffin-stimulated salivary samples were collected 1 month apart. The salivary BE increased significantly from late pregnancy to postpartum without exception. The increase was 2.04 ± 1.17 pH units ($P < 0.001$) on average. The BE increased from 4.79 ± 1.64 (final pH) to 6.82 ± 1.01 (final pH). This change was not due to variation in salivary flow rates, since both unstimulated and paraffin-stimulated flow rates remained unchanged. In control women the difference between the 2 BE measurements was only 0.13 ± 0.47 pH units on average. We concluded that women with high postpartum BE values may have moderate or even low BE values in late pregnancy. In control women, individual variation was found to be low in all variables studied. □ *Buffer effect; pregnancy; saliva; variation*

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Pregnancy is accompanied by marked hormonal and metabolic changes. Pregnancy-related changes have also been found in saliva. In particular, inorganic components of saliva, such as electrolytes (1, 2) and salivary acid-base balance (3), seem to be affected by pregnancy. Salivary pH in unstimulated (4) and paraffin-stimulated (5) saliva is reportedly lower in pregnant women than in non-pregnant women. Data on the effect of pregnancy on salivary flow rate conflict. Most earlier studies have been cross-sectional. When pregnant women were studied longitudinally, no change was found in flow rate of paraffin-stimulated whole saliva (3, 6). This is in contrast to Hugoson (2), who reported a pregnancy-related decrease in parotid saliva. No information is available on the effect of pregnancy on the flow rate of unstimulated whole saliva.

The present study was designed to investigate the changes in unstimulated and paraffin-stimulated salivary flow rates, pH, and buffer effect (BE) between late pregnancy and postpartum. The pregnancy-related variation in pH, BE, and paraffin-stimulated flow rate was compared with that of non-pregnant women.

Material and methods

Eight healthy pregnant women, 29–41 years of age (mean 33.4 years), constituted the study group. They had previously participated in salivary studies and were known to have relatively high salivary flow rates. They agreed to participate in the study during the third trimester of pregnancy, when the pregnancy-related hormonal changes are at their maximum. The control group included 15 non-pregnant women aged 26 to 39 years (mean 30.1 years). The control group consisted of 2 subgroups: women with high BE values (final pH > 6.5) formed the HBE group ($n = 7$), and women with low BE values (final pH < 4.5) the LBE group ($n = 8$). All women had good oral health and had had regular dental care.

Unstimulated (only in pregnant women) and paraffin-stimulated saliva were collected. The collection was carried out at the same time of the day (between 08.00 a.m. and 10.00 a.m.). Prior to collection, the subjects had not eaten or drunk anything for 1 h. Unstimulated saliva was collected by passive drooling. During the collection, the participants sat in a relaxed position with their heads bent forward, and saliva was allowed to drain between the open lips into a test tube via a funnel. About 5 ml was collected. Paraffin-stimulated whole saliva was collected after 60 s of prestimulation (and after 5 min of collection of unstimulated saliva in pregnant women). The subjects chewed a standardized piece of paraffin at their normal pace. Saliva collection was carried out twice. In pregnant women, the first sample was obtained during the last trimester, 32 ± 19 days (mean and SD, range 3; 57 days) prior to delivery and the second one 70 ± 51 days (range 22; 176 days) following delivery during the lactation period when menstruation had not yet started. In the control group, two samples were taken 4 weeks apart in women on oral contraceptives, and one menstrual cycle apart in women with natural cycles. The collection was carried out within the first 3 days of menstruation in women with natural cycles ($n = 10$) and on the same day of the pill cycle in women on oral contraceptives ($n = 5$). The levels of BE in women with natural cycles and women on oral contraceptives did not differ. The same dentist (ML) collected the saliva samples and measured flow rate, pH, and BE.

The pH of stimulated saliva was determined electrometrically immediately following collection of saliva. BE was determined following Ericsson (7). One milliliter of

Table 1. Salivary variables in late pregnancy and postpartum in pregnant women and with an interval of 1 month in control women with either high or low salivary buffer effect

	Pregnant women ($n = 8$)		Women with high salivary buffer effect ($n = 7$)		Women with low salivary buffer effect ($n = 8$)		Significance for		
	3rd trimester	Postpartum	1st collection	2nd collection	1st collection	2nd collection	Group by time interaction*	Group effect*	Time effect*
Variable	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	($P =$)	($P =$)	($P =$)
Unstimulated flow rate (ml/min)	0.4 ± 0.2	0.4 ± 0.2							n.s.† (0.41)
Paraffin-stimulated flow rate (ml/min)	2.3 ± 0.6	2.2 ± 0.5	3.0 ± 0.9	2.7 ± 1.0	1.4 ± 0.4	1.4 ± 0.4	n.s. (0.67)	<0.001	n.s. (0.07)
PH	7.31 ± 0.20	7.41 ± 0.19	7.45 ± 0.05	7.45 ± 0.12	7.16 ± 0.08	7.17 ± 0.07	n.s. (0.24)	<0.001	n.s. (0.31)
Buffer effect (final pH)	4.79 ± 1.64	6.82 ± 1.01	7.18 ± 0.48	6.92 ± 0.86	3.32 ± 0.52	3.29 ± 0.51	<0.001		<0.001†,‡

n.s. = not significant; *repeated-measures analysis of variance; † *t*-test for pairwise comparisons; ‡in pregnant women.

saliva was transferred to a test tube containing 3 ml of HCl (0.005 mol/l). Carbon dioxide was removed by bubbling air through saliva for 20 min. Thereafter, the final pH was measured electrometrically. The results were expressed as means of duplicate measurements, which were either identical or showed only slight variation. The pH values were used without conversions for calculations (7). The flow rates of unstimulated and stimulated saliva were measured with an accuracy of 0.1 ml and calculated as ml/min. Owing to the length of time of the collection procedure (up to 21 min) the pH or BE of unstimulated saliva was not measured.

Statistical analysis of the results was carried out using the repeated-measures analysis of variance to test the effect of group, time (two measurements), and their interaction (group by time). The *t*-test for dependent samples was applied for pairwise comparisons of the different time-points.

Results

Salivary BE values were significantly lower in late pregnancy than after delivery in all pregnant women. The BE was 4.79 ± 1.64 (final pH) in late pregnancy and 6.82 ± 1.01 (final pH) postpartum (Table 1). The mean increase in BE after delivery was as high as 2.04 ± 1.17 pH units (Table 1). Pregnant women differed from control women in this respect ($P < 0.001$ for the group-by-time interaction). In control women, BE values showed only slight variation at the 2 measurements. The change in BE was only 0.13 ± 0.47 pH units (Table 1) on average.

The flow rates of unstimulated and paraffin-stimulated saliva did not differ significantly between late pregnancy and postpartum, and the change between these 2 measurements was small and non-systematic (Tables 1 and 2). The ratio of flow rates (unstimulated/paraffin-stimulated) also remained unchanged.

In control women the differences between the two collections were small and non-systematic in all measured variables (paraffin-stimulated flow rate, pH, and BE), although the level in these measurements differed between the HBE and LBE groups (Tables 1 and 2).

No significant differences were seen between the 2 pH measurements in any group.

Discussion

Our main finding was that women with high postpartum BE values of paraffin-stimulated saliva may have moderate or even low BE values in late pregnancy. It is known that the higher the flow rate, the higher the BE (8, 9). In the present subjects, neither the unstimulated or paraffin-stimulated flow rates, nor the ratio of these 2 flow rates were affected by pregnancy. The changes in BE values could not therefore be explained by any changes in flow rates. Although we could not obtain salivary samples prior to pregnancy, it is still likely that the samples obtained after delivery present the restored BE values, the characteristic values of the individual.

The present findings are in agreement with those of our previous study, in which we used the Dentobuff® Kit for BE determinations. When 16 women were followed during pregnancy and postpartum, the pH and BE values of paraffin-stimulated saliva decreased gradually towards late pregnancy and promptly recovered after delivery. Lactation had no effect on flow rate, pH, or BE values

Table 2. Median (range) in changes between 2 salivary determinations in pregnant ($n = 8$) and in control women ($n = 15$)

	Pregnant women Median (range)	Control women Median (range)
Change in unstimulated flow rate (ml/min)	0.1 (−0.3; 0.3)	
Change in paraffin-stimulated flow rate (ml/min)	0.1 (−0.9; 0.3)	−0.1 (−0.6; 0.3)
Change in pH (pH units)	0.04 (−0.06; 0.45)	0.00 (−0.11; 0.16)
Change in buffer effect (pH units)	2.49 (0.30; 3.90)	−0.06 (−0.75; 0.95)

compared to those of the post-lactation period, when lactation had ceased and menstruation started (3). The Dentobuff® chair-side system (Orion Diagnostica, Espoo, Finland) was a modification of the Ericsson method (10). Both methods only measure BE based on salivary bicarbonate, while the Dentobuff® system is known to underestimate BE in high BE value regions (10–12). Our pregnant women had relatively high postpartum BE values, which was in line with their high salivary flow rates. The mean increase after delivery was as high as 2.04 pH units. The change in salivary BE was systematic and clearly significant statistically, although our study group consisted of only 8 women. Clinically, this change may increase caries susceptibility temporarily.

The interval between the collections probably does not affect the results significantly. Heintze et al. (9) found that an interval of 2 weeks gave well-correlated secretion rates as well as BE values. It is not known how stable the individual BE is over a longer period. In our control women, the interval of 1 month did not affect any of the measured salivary variables, and intraindividual variation in all variables was very low. This is in line with the results of Heintze et al. (9), who suggested that secretion rate and BE are characteristic individually. In the present subjects the collection of saliva and the salivary determinations were well standardized. Also the possible effect of the menstrual phase was controlled by collecting the two samples at the same phase of the menstrual cycle.

Pregnancy-related changes may have untoward effects on oral health and plaque-related periodontal problems are common in pregnancy (13, 14). Less attention has been paid to changes that may increase susceptibility to dental caries. Previous studies have shown that the salivary levels of mutans streptococci and lactobacilli are high during pregnancy and lactation (5, 15). According to our present results women with high postpartum BE values may have moderate or even low BE values in late pregnancy. Thus, even women with good salivary values must be informed about the possibility of impairment of salivary BE values during late pregnancy.

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