

Short-Term Changes in Maternal and Neonatal Urinary Iodine Excretion

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Investigation of maternal urinary iodine (UI) excretion in the immediate antenatal and early postpartum periods showed a precipitous fall in median values from 93 $\mu\text{g}/\text{L}$ antenatally to 36 $\mu\text{g}/\text{L}$ at delivery subsequently rising to 49 $\mu\text{g}/\text{L}$ and 63 $\mu\text{g}/\text{L}$ at days 3 and 10 postpartum respectively. The fate of ingested iodine not appearing in the maternal urine is unknown but measurement of UI in babies born to nursing mothers suggested transfer from the mother with median neonatal values of 117 and 159 $\mu\text{g}/\text{L}$ being recorded at days 3 and 10. While maternal UI seemed to be relatively unaffected by breast feeding, median UI from breast feeding babies (148 $\mu\text{g}/\text{L}$) was significantly greater than in those bottle feeding (50 $\mu\text{g}/\text{L}$). This was also reflected by the finding that no breast feeding baby had a UI values < 50 $\mu\text{g}/\text{L}$ in comparison to 50% of bottle feeders. The depressed values in mothers and relatively high values in their infants could present a false picture and suggest the need to defer any investigations of iodine status at this time. The findings do however suggest a need for further investigations aimed at determining the fate of iodine ingested perinatally and its possible physiological significance in maintaining thyroid status in the mother and neonate.

Introduction

THE QUESTION OF DIETARY IODINE INTAKE in pregnancy and its assessment and impact on neuropsychological development in the fetus has received much recent attention (1–4). While these studies have focused on areas of inadequate dietary iodine intake, recent reports from the United States, Australia, and the United Kingdom, regions previously classified as iodine replete, showing a decrease in urinary iodine excretion (UI) values have caused concern that the observation may become more widespread (5–9). These reports were mirrored by findings from our own group that UI in both first trimester pregnancy and in young female controls had declined alarmingly in recent years (10). The importance of even mild degrees of iodine deficiency in preventing optimal neurological development in the fetus and neonate was emphasized by the finding of region specific temporary profiles of serum thyroid hormones in the human and rat (11,12) which can result in local serum triiodothyronine deficiency in the brain despite the absence of elevations in serum thyrotropin or clinical hypothyroidism. In reviewing this data Visser (13) points out the dependence of deiodinase enzyme activity in maintaining local thyroid hormone levels, particularly in the brain, and their role in adapting to iodine deficiency and stresses the need to avoid even mild iodine deficiency during the fetal and neonatal periods.

In the case of the United States the observed decline between NHANES 1 and NHANES 111 (1988–1994) appears to have been arrested in view of the report (14) that in 2001–2002 median UI was 167.8 $\mu\text{g}/\text{L}$ with a value of 172.6 $\mu\text{g}/\text{L}$ in pregnant women and 132 $\mu\text{g}/\text{L}$ in the nonpregnant population. While dietary iodine intake is traditionally assessed by measurement of urinary iodine excretion, there is disagreement on the pattern of iodine excretion during pregnancy (15). Some groups including ourselves have shown an increase in UI early in pregnancy with a tendency towards lower values at delivery (16–18). More recently Bourdoux (19) reported low UI in pregnant mothers despite their receiving iodine prophylaxis (150 $\mu\text{g}/\text{day}$) and posed the question, “where is the iodine going to?”

The purpose of this communication was to examine the pattern of both maternal and neonatal UI at delivery and in the early postnatal period with a view to elucidating the accuracy of urinary iodine excretion in defining maternal or neonatal iodine status at delivery.

Materials and Methods

Subjects

Antenatal urine specimens were obtained from 42 women at a median of 39 weeks gestation (range 35–42 weeks). Urine samples were also obtained from 23 nonpregnant female controls sampled at the same time of the year as pregnant

mothers to avoid known seasonal variations in urinary iodine excretion. Apart from iron tablets, no dietary supplements were prescribed. Betadine or other iodine-containing disinfectants were not used at delivery. Smoking habits were not recorded although all were discouraged from smoking during pregnancy. None of the patients or controls had a history of thyroid disease although thyroid antibodies were not measured.

Repeat specimens were available at delivery (Day 0) in 29 subjects and at days 3 and 10 postpartum in 23 subjects, of whom 10 were breast feeding and 13 bottle feeding. Urine specimens were obtained from 17 babies on days 3 and 10.

Statistical analysis

Results were compared using Student *t* test for unpaired samples and Wilcoxon's rank sum test.

Methods

Urinary iodine estimation

UI was measured using the ammonium persulfate digestion microplate method as described by Ohashi *et al.* (20). Results were expressed as micrograms of iodine per liter urine. Quality control was assessed under the Centers for Disease Control (CDC, Atlanta, GA) EQUIP program. Study group values were expressed as medians and percentage of individual values indicative of iodine deficiency (<50 $\mu\text{g/L}$) as recommended by the World Health Organization (8).

Statistical analysis was performed using Wilcoxon's rank sum test for unpaired samples and the chi-square test (Fischer's exact test).

Results

Results of median urinary iodine concentration are shown in Figure 1. The median UI of 83.5 $\mu\text{g/L}$ (mean $106 \pm 14.1 \mu\text{g/L}$) in antenatal subjects fell to 36 $\mu\text{g/L}$ ($65.4 \pm 15.5 \mu\text{g/L}$) at delivery and remained depressed (49 $\mu\text{g/L}$; mean $61.0 \pm 9.5 \mu\text{g/L}$) at day 3 and 63 $\mu\text{g/L}$ (mean $82.9 \pm 16.1 \mu\text{g/L}$) at day 10. The equivalent seasonally adjusted (winter) median value for nonpregnant females at this time was 91 $\mu\text{g/L}$ (mean $110.9 \pm 10.2 \mu\text{g/L}$). In contrast, urine samples collected from infants born to study mothers showed median UI values of 117 $\mu\text{g/L}$ (mean $180.0 \pm 55 \mu\text{g/L}$) and 159 $\mu\text{g/L}$ (mean $175 \pm 48.4 \mu\text{g/L}$) at days 3 and 10 respectively.

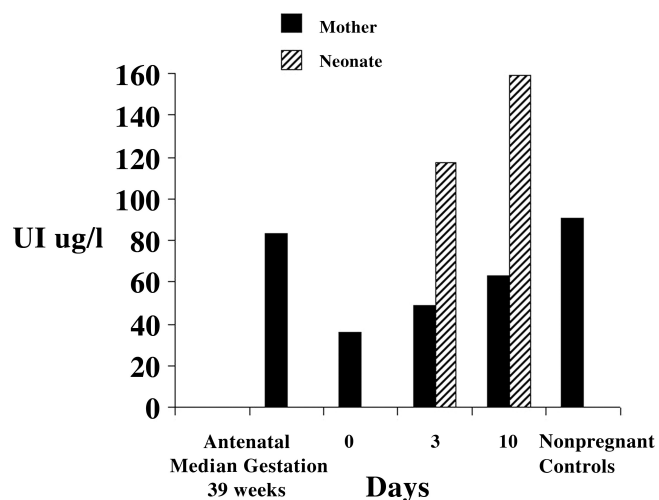


FIG. 1 Sequential urinary iodine (UI $\mu\text{g/L}$) in pregnant mothers and their offspring.

Values for median UI and percentage <50 $\mu\text{g/L}$ in mothers and their neonates before and at days 1, 3, and 10 following delivery are shown in Table 1. The distribution of individual UI values <50 $\mu\text{g/L}$ was 21.4% in antenatal subjects which was identical to that of 21.7% seen in nonpregnant controls. However this percentage increased to 58.6% at day 1 and remained elevated at 43.5% at day 3 and 30% at day 10 reflecting the fluctuations in median maternal UI. Values for UI and percentage <50 $\mu\text{g/L}$ in mothers and babies subdivided on the basis of breast or bottle feeding are also shown in Table 1. When median values for UI taken from breast or bottle feeding mothers (day 3 and day 10 combined) and babies who were breast fed (72.5 $\mu\text{g/L}$) or bottle fed (59.5 $\mu\text{g/L}$) were compared they were found not to be significantly different. This also applied to the percentage of values <50 $\mu\text{g/L}$ (breast fed 38.8% and bottle fed 28.6%). Equivalent values for median UI in babies from breast feeding mothers showed wide variations with individual values of 374 and 295 $\mu\text{g/L}$ at day 3 and a value of 405 $\mu\text{g/L}$ on day 10 resulting in findings from these days not being significantly different. This was not the case in bottle fed babies. Median values from day 3 and day 10 and from the two groups combined are shown in Table 1.

TABLE 1. MEDIAN URINARY IODINE (UI) AND PERCENTAGE <50 $\mu\text{g/L}$ IN MOTHERS AND THEIR NEONATES BEFORE AND AT DAYS 1,3 AND 10 FOLLOWING DELIVERY. SIMILAR VALUES ARE ALSO SHOWN FOR MOTHERS AND BABIES DIVIDED ON THE BASIS OF BREAST OR BOTTLE FEEDING.

Results	N	Median UI $\mu\text{g/l}$	% UI <50 $\mu\text{g/l}$	Median UI $\mu\text{g/l}$	% UI <50 $\mu\text{g/l}$	Median UI $\mu\text{g/l}$	% UI <50 $\mu\text{g/l}$
Antenatal	41	93.0	21.4				
Mothers Day 0	30	36.0	58.6				
Day 3	23	49.0	43.5				
Day 10	23	63.0	30.0				
				Breast		Bottle	
				Day 3 + 10		Day 3 + 10	
				72.5	38.8	67.5	28.6
Babies Day 3	17	117.0	10.0				
Day 10	17	159.0	2.7	148.5	0.0	50.0	50.0
Nonpregnant controls	23	91.0	21.7				

The median UI of 148 $\mu\text{g/L}$ in babies from breast feeding mothers (days 3 and 10 combined) was significantly greater than that in bottle feeders (50 $\mu\text{g/L}$; $p < 0.01$). This was also reflected by the finding that no breast feeding baby had a UI values $< 50 \mu\text{g/L}$ in comparison to 50% of bottle feeders.

Discussion

Earlier reports have shown a decline in maternal UI between booking and delivery but there is little reported work at delivery (16,17,19,21). The results from the present study confirm our earlier findings (18) of a precipitous fall in UI at delivery and establishes that this is an acute effect from which recovery is observed at 3 and 10 days postpartum. The reason for such a sharp decline is unknown but may be related to a transfer of iodide from mother to neonate as neonatal UI was significantly greater than that of the mother at these times. This appears to be independent of breast or bottle feeding as maternal UI values were similar in both groups. No restriction was placed on oral fluid intake during labor, which in all cases was < 12 hours. Mothers received IV infusions associated with epidural or oxytocin augmentation.

This would imply a dramatic increase of iodide uptake by the mammary glands or via the fetoplacental unit (15,21). Increased uptake of iodide by the maternal mammary glands at delivery is supported by the findings of increased expression of the sodium iodide symporter (NIS) as a consequence of the altered endocrine environment at this time (22). There is some evidence of preferential transfer of iodide from mother to fetus as we have shown greater UI in neonates than in their mothers (18,23) which has been confirmed in the present study. Similarly upregulation of NIS in both fetal and placental tissues of rats on low iodine diets has been reported (24). Another cause for fetal UI exceeding that of the mother may be the increase in placental expression of the deiodinase enzymes D2 and particularly D3 (25,26) which would serve as a source of placental iodide. As far as the authors are aware there is no evidence that iodide is stored in the placenta but the sudden fall in maternal UI at delivery together with the relatively greater neonatal UI would support the hypothesis of maternal to fetal transfer from placental storage. Such storage or at least increased placental transfer of iodine would be required in view of the extremely high iodine turnover reported in neonates (1,2).

The findings also reaffirm our observation (23) that iodine in the form of breast milk appears to have greater bioavailability than that in formula feeds as not only did the babies from the former group demonstrate a higher median UI, but no breast fed baby had a UI $< 50 \mu\text{g/L}$ while 50% of bottle feeders had such values. The iodine content of the four formula preparations being fed to neonates was 100–150 $\mu\text{g/L}$ and has remained relatively constant in recent years.

As far as the authors are aware this is the first demonstration of the acute changes in UI at delivery and in the early neonatal period, at least in areas of borderline to low iodine intake. The depressed values in mothers and relatively high values in their infants could present a false picture of iodine status and suggest the need to defer any investigations of iodine status at this time. The findings do however suggest a need for further investigations aimed at determining the fate of iodine ingested perinatally and its possible physiological significance in maintaining thyroid status in the mother, fetus, and neonate.

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