# *Maternal and Umbilical Cord Blood Levels of Zinc and Copper in Active Labor Versus Elective Caesarean Delivery at* ***Khartoum*** *Hospital,* ***Sudan***

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# Maternal and Umbilical Cord Blood Levels of Zinc and Copper in Active Labor Versus Elective Caesarean Delivery at Khartoum Hospital, Sudan

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**Abstract** A case–control study was conducted in Khartoum Hospital Sudan to determine maternal and umbilical cord blood levels of zinc and copper in active labor versus elective cesarean delivery. Cases were women delivered vaginally and controls were women delivered by elective cesarean (before initiation of labor). Paired maternal and cord zinc and copper were measured using atomic absorption spectrophotometry. The two groups (52 paired maternal and cord in each arm) were well matched in their basic characteristics. In comparison with cesarean delivery, the median (interquartile range) of both maternal [87.0 (76.1–111.4) vs. 76.1 (65.2–88.3) μg/dL, $P = 0.004$] and cord zinc [97.8 (87.0–114.1) vs. 81.5(65.2–110.2) μg/dL $P = 0.034$] levels were significantly higher in the vaginal delivery. While there was no significant difference in the maternal copper [78.8 (48.1–106.1) vs. 92.4 (51.9–114.9) μg/dL, $P = 0.759$], the cord copper [43.5(29.9–76.1) vs. 32.2(21.7–49.6) μg/dL, $P = 0.019$] level was significantly higher in vaginal delivery. There was no significant correlation between zinc (both maternal and cord) and copper. While the cord zinc was significantly correlated with maternal zinc, there was no significant correlation between maternal and cord copper. The current study showed significantly higher levels of maternal and cord zinc and cord copper in women who delivered vaginally compared with caesarean delivery.

**Keywords** Zinc · Copper · Cesarean delivery · Pregnancy · Sudan

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## Introduction

Trace elements such as selenium, zinc and copper are essential nutrients with regulatory, immunologic and antioxidant functions resulting from their actions as essential components or cofactors of enzymes throughout metabolism [1, 2]. Trace elements are also essential cofactors for metalloproteinases and the enzymes catalase, superoxide dismutase (SOD) and cytochrome oxidase [3].

Pregnancy is the period of increased metabolic demands, and deficiency of one or more of the trace elements can lead to adverse maternal and perinatal outcomes [4]. The transport of the trace element to the fetus is not fully understood; while some elements have active, the others have passive placental transport [5, 6].

Although the exact mechanism initiating labor is not fully understood, during labor, the metabolic requirements increase sharply for both the mother and the fetus [7]. Currently, there are two plausible general hypotheses for human parturition; pregnancy maintenance hypothesis and the uterotonin,

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**Table 1** Comparison of mean (SD) of characteristics of women who delivered vaginally and by cesarean in Khartoum, Sudan

| Variables | Vaginal delivery ($n$ = 52) | Cesarean delivery ($n$ = 52) | $P$ |
|---|---|---|---|
| Age, years | 28.1 (4.6) | 29.2 (4.1) | 0.239 |
| Parity | 1.6 (1.5) | 1.7 (1.3) | 0.890 |
| Gestational age, weeks | 38.5 (1.0) | 38.8 (1.0) | 0.190 |
| Body mass index, kg/cm$^2$ | 28.2 (1.7) | 28.2 (2.2) | 0.986 |
| Hemoglobin, g/dl | 10.8 (1.8) | 11.1 (1.4) | 0.075 |
| Birth weight, g | 3184.0 (196.2) | 3209.9 (234) | 0.550 |

prostaglandin and oxytocin theory [7, 8]. Therefore, researches on the mechanism/initiation of labor are of paramount importance for both academicians as well as managing clinicians. There are few published data on the role of trace elements in the mechanism of labor [9]. The current study was conducted to investigate maternal and umbilical cord blood levels of zinc and copper in active labor versus elective cesarean.

## Material and Methods

A case-control study was conducted at Khartoum Hospital, Sudan during April to August 2013. A total sample size of 52 women in each arm of the study was calculated with the difference in the mean levels of zinc and copper to provide 80 % power to detect a 5 % difference at $\alpha = 0.05$. We assumed that 10 % of women would have incomplete data. Cases were women delivered vaginally and controls were women delivered by elective cesarean (before initiation of labor). In both arms of the study, women were at term gestation (37–41 completed weeks). Newborns were ≥2500 g at birth, and there was no history of fetal problems. Mothers with any medical disorder (e.g. diabetes or hypertension) were excluded from both cases and controls.

**Table 2** The median (interquartile) of maternal and cord zinc and copper in vaginal and cesarean delivery

| Variable | Vaginal delivery ($n$ = 52) | Cesarean delivery ($n$ = 52) | $P$ |
|---|---|---|---|
| Mother zinc, μg/dL | 87.0 (76.1–111.4) | 76.1 (65.2–88.3) | 0.004 |
| Cord zinc, μg/dL | 97.8 (87.0–114.1) | 81.5 (65.2–110.2) | 0.034 |
| $P$ | <0.001 | <0.001 | |
| Mother copper, μg/dL | 78.8 (48.1–106.1) | 92.4 (51.9–114.9) | 0.759 |
| Cord copper, μg/dL | 43.5(29.9–76.1) | 32.2(21.7–49.6) | 0.019 |
| $P$ | <0.001 | <0.001 | |

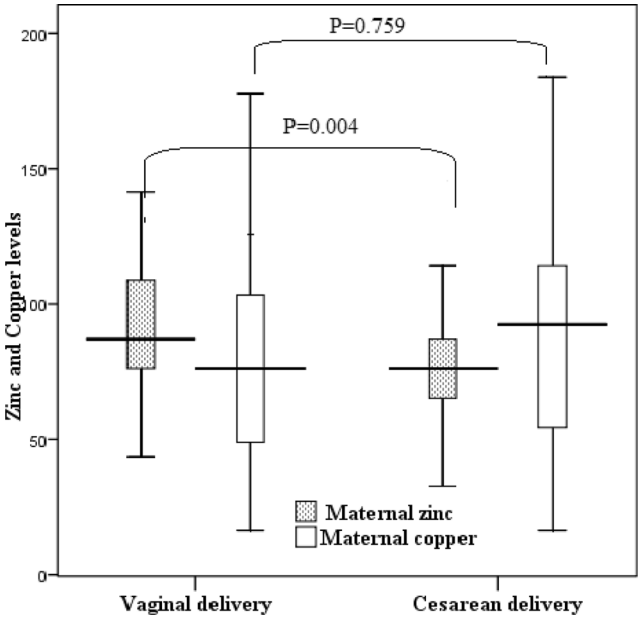


**Fig. 1** Comparing maternal levels of zinc and copper in vaginal and cesarean delivery

Written informed consent was obtained from the mothers before delivery of the neonates. This study received ethical clearance from the Research Board of the Institution.

Medical and obstetrics data were collected using a pretested questionnaire. Study variables included maternal age, and maternal weight and height to calculate body mass index (BMI) using the formula: BMI (kg/m$^2$) = weight (kg) / height (m$^2$). According to the hospital policy, spinal anesthesia was used for the elective cesarean deliveries.

Then, 5 ml of blood was taken (maternal and cord) and allowed to clot, and centrifuged at 2500 rpm for 15 min at room temperature to obtain serum which was stored at −20 °C till the zinc and copper assay which was performed by atomic absorption spectrophotometry (SOLAAR, Atomic Absorption Spectrophotometer, Thermo Electron, Cambridge, UK).

In both arms of the study, maternal samples collected before delivery, and the samples of umbilical cord were drawn immediately following delivery.

## Statistical Analysis

Data were entered in a computer using SPSS for Windows. Means and proportions of the basic socio-demographic and clinical data were compared between women who delivered vaginally and those who had a cesarean delivery using the Student's $t$ test and $X^2$ test, respectively. Zinc and copper levels were not normally distributed and were compared between the two groups of delivery by Mann–Whitney test. Correlations between the zinc and copper levels were conducted. $P < 0.05$ was considered significant.

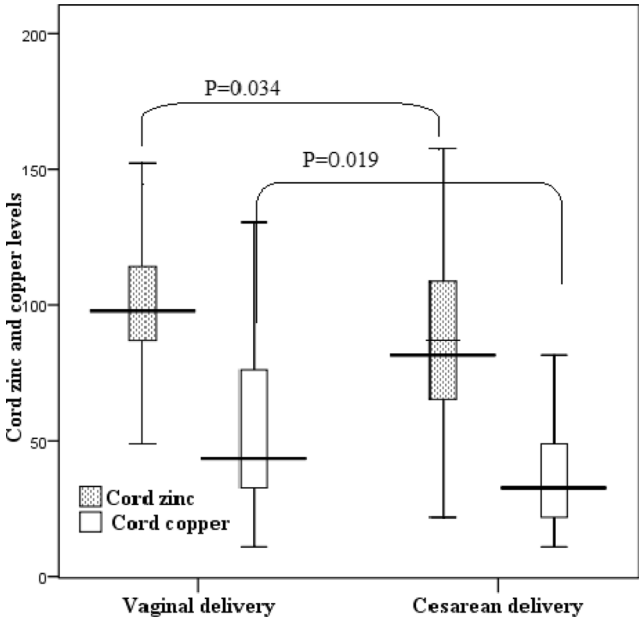


**Fig. 2** Comparing cord levels of zinc and copper in vaginal and cesarean delivery

## Results

The two groups were well matched, and there is no significant difference in the age, parity, gestational age, BMI and hemoglobin (Table 1).

In comparison with cesarean delivery, the median (interquartile range) of both maternal [87.0 (76.1–111.4) vs. 76.1(65.2–88.3) μg/dL, $P = 0.004$] and cord zinc [97.8 (87.0–114.1) vs. 81.5(65.2–110.2) μg/dL $P = 0.034$] levels were significantly higher in the vaginal delivery. While there was no significant difference in the maternal copper [78.8 (48.1–106.1) vs. 92.4 (51.9–114.9) μg/dL, $P = 0.759$], the cord copper [43.5(29.9–76.1) vs. 32.2(21.7–49.6) μg/dL, $P = 0.019$] level was significantly higher in vaginal delivery (Table 2, Figs. 1 and 2).

In comparison with the maternal levels, the median (interquartile range) of the cord zinc was significantly higher and cord copper was significantly lower (Table 2).

There was no significant correlation between zinc (both maternal and cord) and copper. While the cord zinc was significantly correlated with maternal zinc, there was no significant correlation between maternal and cord copper (Table 3).

## Discussion

The main finding of the current study was the higher levels of maternal zinc, cord zinc and cord copper in the vaginal delivery. Recently, Lazer et al. observed that umbilical cord levels of zinc and copper levels were significantly higher in vaginal delivery compared with cesarean delivery [9]. Zinc and copper play a vital role in the performances of the immune, antioxidant systems and affecting the complex network of the genes (nutrigenomic) with cytokines which are involved in the susceptibility to the diseases or disorders [10]. It has been recently shown that zinc and copper have a potent ability to induce TNF-α production [11]. It is worth to be mentioned that we have recently observed higher concentrations of IFN-gamma, IL-4 and IL-10 in the peripheral and placental sera in the vaginal delivery compared with cesarean delivery [12].

The exact processes in human pregnancy which are involve in the initiation of labor are not clearly understood. Perhaps the uterotonin, prostaglandin, oxytocin, endothelin and platelet-activating factor that lead contractility of the myometrium, the ripening of the cervix, theory is the plausible one [7]. Furthermore, an acute inflammation gene expression signature in the fetal membranes in the absence of evidence of chorioamnionitis was reported [13]. On the other hand, the uterine activation/expression (in the presence of estrogen and progesterone) can be regulated by estradiol levels and matrix metalloproteinases (MMP). Trace elements are important cofactors in the action of MMPs which are found in the decidua, fetal membranes and amniotic fluid and have several important biological processes including the initiation of labor and the parturition itself [8, 14, 15].

The current study showed that the cord zinc was significantly higher and cord copper was significantly lower that the maternal level of these elements and the cord zinc was significantly correlated with maternal zinc. This goes with the previous reports where Perveen et al. [5] observed the mother-to-fetus uphill zinc transfer is clear throughout the last trimester

**Table 3** Correlation between maternal and cord zinc and copper

| Variables | Maternal zinc | | Maternal copper | | Cord zinc | | Cord copper | |
|---|---|---|---|---|---|---|---|---|
| | *R* | *P* | *r* | *P* | *r* | *P* | *R* | *P* |
| Maternal zinc | – | – | 0.273 | 0.111 | 0.401 | <0.001 | 0.036 | 0.728 |
| Maternal copper | 0.273 | 0.111 | – | – | 0.009 | 0.930 | 0.088 | 0.387 |
| Cord copper | 0.036 | 0.728 | 0.088 | 0.387 | 0.036 | 0.728 | – | – |

and copper remains in cord blood plasma at much lower concentrations than in the mother, and Al-Saleh et al. [6] reported an active and passive placental transport for zinc and copper, respectively, between mother and fetus. One of the limitations of the current study that it failed to differentiate if the high levels of zinc and copper in the vaginal delivery was a cause or effect. A longitudinal study including other trace elements such as selenium is needed.

## Conclusion

The current study showed significantly higher levels of zinc and copper in women who delivered vaginally compared with caesarean delivery.

**Competing Interests** Authors received no fund. The authors declare that they have no competing interests.

**Compliance with Ethical Standards** All procedures performed in this study were in accordance with the ethical standards of the Faculty of Medicine—University of Khartoum—Sudan and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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