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# Measurement of CT Values of Brain Tissue in Premature Infants

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**Abstract :** **Objective** The CT values of brain tissue of premature infants are usually low and it is difficult to assess if they stand in the normal range of CT values of premature infants. This paper aims at studying the differences of brain CT values between the premature and term infants. **Methods** Seventy-six premature infants were divided into 2 groups according to the gestational age: 28 - 33<sup>+6</sup> weeks group (n = 36) and 34 - 36<sup>+6</sup> weeks group (n = 40). Fifty term infants were used as the control group. The cranial CT scan was taken and the CT values of various regions of brain tissues were measured. **Results** The CT values of cerebellum, brainstem, basal segment, thalamus, white matter and grey matter in the two premature infants groups were significantly lower than those in the control group ( $P < 0.01$ ). The CT values of the above regions of brain tissues in the 28 - 33<sup>+6</sup> weeks group were significantly lower than those in the 34 - 36<sup>+6</sup> weeks group ( $P < 0.01$ ). **Conclusions** This study shows that the brain CT values of the premature infants are significantly lower than those of the term infants, thus the reference range of the brain CT values of full term neonates is not fit for the premature newborns. [Chin J Contemp Pediatr, 2003, 5(6): 503 - 504]

**Key words :** Brain; Tomography; X-ray computed; Infant, premature

## 早产儿脑组织 CT 值测定

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**[摘要]** **目的** 早产儿脑组织 CT 值普遍较低, 难以判断是否为正常范围。该文探讨早产儿正常脑组织 CT 值与足月儿脑组织 CT 值的差异。 **方法** 对 76 例早产儿(按胎龄分为 28 ~ 33<sup>+6</sup> 周早产儿 36 例及 34 ~ 36<sup>+6</sup> 周早产儿 40 例)及 50 例正常足月新生儿(胎龄为 37 ~ 42 足周)进行头颅 CT 检查并测定各部位脑组织 CT 值。 **结果** 28 ~ 33<sup>+6</sup> 周早产儿和 34 ~ 36<sup>+6</sup> 周早产儿小脑、脑干、基底节、丘脑、白质、灰质 CT 值均低于足月儿相应部位脑组织 CT 值, 其差异有显著性( $P < 0.01$ )。28 ~ 33<sup>+6</sup> 周早产儿不同部位脑组织 CT 值均低于 34 ~ 36<sup>+6</sup> 周早产儿相应部位脑组织 CT 值, 其差异有显著性( $P < 0.01$ )。 **结论** 早产儿脑组织 CT 值明显低于足月新生儿, 故早产儿脑组织 CT 值有自己的正常值范围。 [中国当代儿科杂志, 2003, 5(6): 503 - 504]

**[关键词]** 脑; 体层摄影术; X 线计算机; 早产儿

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It was found that the CT values of the brain tissue in the preterm neonates were generally low. It was difficult to judge if they were normal or not. The CT values of various areas of brain tissues of preterm neonates who had various gestational ages (GA) were measured and the differences of brain CT values between the premature and term infants were investigated in this study.

## Subjects and methods

### Subjects

Seventy-six premature infants without a history of asphyxia and other diseases hospitalized in the First Hospital of Hebei University from 1999 to 2000 were enrolled in this study. They were divided into two

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groups according to the gestational age (GA) : 28 - 33<sup>+6</sup> weeks group (n = 36) and 34 - 36<sup>+6</sup> weeks group (n = 40). Fifty healthy term neonates with GA 's of 37 - 42 weeks made up the control group. No differences of gender and age were noted among the three groups , whereas the difference of birth weight among them was significant. See Table 1.

Table 1 Gender , age and birth weight of the 3 groups  
(  $\bar{x} \pm s$  )

Groups	n	male	female	age(d)	weight (g)
28 - 33 <sup>+6</sup> weeks	36	21	15	8.5 $\pm$ 3.5	1 501 $\pm$ 308 <sup>a,b</sup>
34 - 36 <sup>+6</sup> weeks	40	25	15	7.5 $\pm$ 2.8	2 134 $\pm$ 312 <sup>a</sup>
37 - 42 weeks	50	32	18	8.0 $\pm$ 4.8	3 170 $\pm$ 526

Note : a vs the 37 - 42 weeks group  $P < 0.01$  ; b vs the 34 - 36<sup>+6</sup> weeks group  $P < 0.01$

Methods

All the subjects were given a cranial CT scan between 3 hours and 12 days after birth. The Matrix was 340  $\times$ 340 , the window width was 100 Hu and

the window centre was 30 Hu. The scanning range was from the acusiar-canthus line to the top of the cranium of the subjects , including 8 layers. The thickness of each layer was 10 mm and the distance between each layer was 10 mm.

Statistical analysis

All statistical data were expressed as  $\bar{x} \pm s$  . ANOVA and  $q$  test were used to analyze the differences of data.

Results

The CT values of the cerebellum , brainstem , basal ganglia , thalamus , white matter and grey matter in the 28 - 33<sup>+6</sup> weeks group and the 34 - 36<sup>+6</sup> weeks group were lower than those of the control group respectively and the differences were significant (  $P < 0.01$  ) . The CT values of the various brain tissues in the 28 - 33<sup>+6</sup> weeks group were lower than those of the 34 - 36<sup>+6</sup> weeks group and the differences were also significant (  $P < 0.01$  ) . See Table 2.

Table 2 CT values of various regions of brain tissues in the 3 groups(  $\bar{x} \pm s$  , Hu)

Groups	n	cerebellum	brain stem	basal ganglia	thalamus	white matter	grey matter	ventricle
37 - 42 weeks	50	28.9 $\pm$ 2.9	27.8 $\pm$ 2.3	26.8 $\pm$ 2.1	26.9 $\pm$ 2.3	18.9 $\pm$ 2.7	30.4 $\pm$ 4.0	6.9 $\pm$ 2.8
34 - 36 <sup>+6</sup> weeks	40	24.1 $\sim$ 3.8 <sup>a</sup>	22.8 $\pm$ 3.8 <sup>a</sup>	20.8 $\pm$ 3.9 <sup>a</sup>	21.7 $\pm$ 3.5 <sup>a</sup>	16.2 $\pm$ 3.2 <sup>a</sup>	26.9 $\pm$ 4.4 <sup>a</sup>	6.4 $\pm$ 2.9
28 - 33 <sup>+6</sup> weeks	36	20.2 $\pm$ 4.8 <sup>a,b</sup>	21.3 $\pm$ 3.4 <sup>a,b</sup>	20.1 $\pm$ 3.8 <sup>a,b</sup>	18.8 $\pm$ 3.6 <sup>a,b</sup>	15.2 $\pm$ 3.9 <sup>a,b</sup>	25.4 $\pm$ 6.9 <sup>a,b</sup>	5.6 $\pm$ 3.6

Note : a vs the 37 - 42 weeks group  $P < 0.01$  ; b vs the 34 - 36<sup>+6</sup> weeks group  $P < 0.01$

Discussion

CT value is a unit to express tissue density and can reflect the density range of different tissues. It is a credible index for the diagnosis of brain edema. When CT value drops by 1 Hu , it indicates that the water content of brain tissue increases by 1.3 % . CT value has been used in the field of the neonatal diseases diagnosis since 1976. LI, et al<sup>[1]</sup> reported that the CT value of brain white matter in normal full term infants was 18 - 28 Hu which was significantly lower than that of normal children and adults. The marker, which the CT value of brain white matter was less than 18 Hu , has been used as one of the diagnostic criteria of hypoxic-ischemic encephalopathy (HIE) in term neonates<sup>[2]</sup>. The range of normal

brain CT value of premature infants has not been reported in China. This study revealed that the CT values of brain white matter in premature infants were 9 - 21 Hu , which were obviously lower than those of term neonates and maybe be used as reference range of brain CT value of premature infants. And the lower the gestational age , the lower the CT value of brain tissue , which was accordant with the report of a foreign author<sup>[3]</sup>. The reasons may be because the water content of brain tissues in premature infants is higher and the brain tissues of premature infants are short of myelinization<sup>[4]</sup>. So the normal range of CT values of the term infants is not fit for the preterm infants. Otherwise , the developing brain tissue with low density in premature infants may be misdiagnosed as brain edema or HIE.

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$>0.05$ )。尿  $_{2}\text{-MG}$  升高程度较血  $_{2}\text{-MG}$  升高程度更显著 ( $P < 0.01$ ), 且与患儿窒息程度呈正相关 ( $r = 0.637, P < 0.01$ )。

3 讨论

$_{2}\text{-MG}$  是一种主要由淋巴细胞等有核细胞产生, 经肾小球滤过的低分子旦白质, 因其分子量 (11 800 道尔顿) 小, 故可自由通过肾小球滤过膜, 而 99.9 % 以上又在肾近曲小管经小管细胞的胞饮作用进入胞浆, 在胞浆内被溶酶体降解为氨基酸, 仅有极微量从尿中排出<sup>[1]</sup>。因此, 在机体  $_{2}\text{-MG}$  产生恒定状态下, 通过血、尿内  $_{2}\text{-MG}$  值的测定则能较敏感的反应肾小球及肾小管功能的损害, 其升高程度与肾功能损害程度成正相关<sup>[2]</sup>。血  $_{2}\text{-MG}$  升高提示肾小球滤过率 (GFR) 下降; 而尿  $_{2}\text{-MG}$  升高提示肾小管尤其是肾近曲小管重吸收能力下降。本文观察到新生儿窒息后血、尿  $_{2}\text{-MG}$  均显著高于正常新生儿组, 重度窒息新生儿又较轻度窒息者明显升高, 提示窒息程度越重肾功能受损程度越重。因此, 血、尿  $_{2}\text{-MG}$  值的测定可作为判断窒息后肾功能受损的一项敏感指标。

NAG 是一种溶酶体酶, 在正常的肾组织特别是肾小管上皮细胞中含量丰富, 由于其分子量为 14 000, 不能通过肾小球滤膜, 因此正常时尿中含量极低<sup>[3]</sup>。而当新生儿窒息致肾小管上皮细胞缺血缺氧损伤时, 肾小管上皮细胞肿胀、坏死、细胞膜通透性增加, 大量 NAG 排入尿中, 但此时肾小管重吸收功能却大大下降, 最终导致尿中 NAG 含量明显增高。本组资料显示窒息新生儿尿 NAG 活性明显高于正常新生儿, 而且重度窒息患儿高于轻度窒息患儿。同时还观察到在血、尿  $_{2}\text{-MG}$  尚未增高的 5 例窒息新生儿中已见尿 NAG 增高, 提示尿 NAG 活性测定可能更早反映肾功能尤其是肾小管的损害。测定尿 NAG 含量是反映窒息新生儿早期肾小管或

近曲小管功能改变的敏感指标。

新生儿窒息时由于缺氧导致血液重新分配, 肾血管收缩, 肾血流急剧减少, 引起肾组织缺氧、缺血。研究证明, 肾组织缺氧能直接导致肾小管上皮细胞的肿胀、坏死、脱落, 肾髓质出血和 GFR 下降<sup>[2]</sup>, 从而产生明显肾功能损害甚至急性肾功能衰竭。Perlman 等<sup>[4]</sup>曾报道新生儿窒息后各脏器损伤发生率达 70 %, 肾损伤则占 57 %。另有报道 34 例窒息新生儿肾损害中, 半数为肾小管损伤, 半数为肾小球、肾小管混合损伤<sup>[5]</sup>。本文 28 例窒息新生儿尿 NAG 活性和血、尿  $_{2}\text{-MG}$  值均高于正常新生儿组, 亦提示窒息后肾功能均存在不同程度之损害。因此, 对于窒息新生儿除重视脑、心等脏器损伤外, 不能忽视其对肾功能的影响。因新生儿肾脏对缺氧非常敏感, 窒息即使不超过 24 小时亦能产生肾功能损害, 且最先损伤肾小管。本文窒息组新生儿血、尿  $_{2}\text{-MG}$  值与正常新生儿组上限值比较, 有 12 例血  $_{2}\text{-MG}$  值升高, 15 例尿  $_{2}\text{-MG}$  值升高, 二者升高例数无显著差别, 但尿  $_{2}\text{-MG}$  升高程度更明显, 且与患儿窒息程度呈正相关。提示窒息后肾小管损害明显重于肾小球功能损害。

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