



Urinary Anomalies in Fetus with Neural Tube Defects

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Abstract

Background: The objective of this study is to analyze the incidence of congenital urogenital malformations in human fetuses with neural tube defects (NTDs). **Methods:** We studied 320 human fetuses (214 males and 106 female) ranged in age from 12 to 35 weeks post-conception (WPC). The fetuses were carefully dissected with the aid of a stereoscopic lens with 16/25× magnification. The abdomen and pelvis were opened to identify and expose the urogenital organs. We studied the incidence of renal, ureteral, bladder, urethral, testicular, epididymal, vas deferens, prostate and penile and uterine anomalies. The renal anomalies were divided into rotation, fusion, number and ascension. We observed the presence of seminalvesicle and ureteral duplication, bladderseparation, hypospadias and posterior urethral valve. **Results:** We observed 17 fetuses (5.31%) with NTDs ranged in age between 18 to 34 WPC, weighted between 170 and 2325 g, and had crown-rump length between 13 and 34 cm. Of the 17 fetuses, 4 (23.4%) presented some kind of anomaly of the urogenital system. Renal anomalies were found in three fetuses (17.6%) and a duplication of the left ureter in one fetus (5.8%). We do not observe anomalies in genital organs in this sample. **Conclusions:** We concluded that the urogenital anomalies in human fetuses with neural tube defects are significant with an incidence superior a 20%. In this study we have not found severe urogenital anomaly that causes damage of the body function.

Keywords

Neural Tube Defects, Urinary System, Genital System, Embryology

Subject Areas: Anatomy & Physiology, Urology

1. Introduction

Neural tube defects (NTDs) are one of the commonest congenital mal-formations of the central nervous system,

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with an average prevalence at birth of 1 per 1000 [1]. NTDs may be classified as spinal (spina bifida) and cranial (cranioschisis). Cranioschisis could be divided into cephalocele (herniation of cranial content) and anencephaly (absence of the calvarium) [2].

Anencephaly is the most severe of fetal NTDs, resulting from failure of the neural tube to close at the base of the skull in the third or fourth week (day 26 to 28) after conception, leaving the skull bones that usually surround the head unformed [1].

Despite ethical conflicts the literature shows some reports about the use of anencephalic fetuses' organs for transplantation [3]-[6]. The organ structure of anencephalic fetuses and children is almost unknown. Recently the structure of anencephalic fetal kidneys [7], bladder [8] and penis [9] was studied.

The study of the incidence of urogenital anomalies in children and in patients that have some syndromes such as cystic fibrosis [10], chromosomal anomalies [11] and in male fetuses [12] are very frequent. However, studies in the literature performed in human fetuses with NTDs evaluating the incidence of genitourinary anomalies are rare [2].

The objective of this study is to analyze the incidence of congenital urogenital malformations in human fetuses with neural tube defects.

2. Material and Methods

The present work received institutional review committee and parent approval. This work was carried out in accordance to the ethical standards of the responsible institutional committee on human experimentation.

We studied 320 human fetuses (214 males and 106 female) ranged in age from 12 to 35 weeks post-conception (WPC), during the period from January 1996 through June 2013. The fetuses were macroscopically well preserved. The gestational age of the fetuses was determined in WPC, according to the foot-length criterion. Presently, the foot-length criterion is considered the most acceptable parameter used to calculate the gestational age [13]-[16]. The fetuses were also evaluated regarding crown-rump length (CRL) and body weight immediately before dissection. The same observer analyzed the measurements.

After the measurements the fetuses were carefully dissected with the aid of a stereoscopic lens with 16/25× magnification. The abdomen and pelvis were opened to identify and expose the urogenital organs.

We studied the incidence of renal, ureteral, seminalvesicle, urethral, testicular, epididymal, vas deferens, prostate and penile and uterine anomalies. The renal anomalies were divided in rotation, fusion, number and ascension. We observed the presence of bladder and ureteral duplication, bladderseptation, hypospadias and posterior urethral valve. The testicular anomalies were divided in number and position. The epididymal anomalies were divided in obliteration, disjunction and number [12]. The vas deferens anomalies were divided in obliteration and number.

3. Results

We observed 17 fetuses (5.31%) with NTDs-16 with anencephaly (8 male and 8 female) and 1 with cephalocele (male). We observed in 7 fetuses with anencephaly the presence of spina bifida associated. The **Figure 1** shows some of the fetuses with NTDs studied.

The NTDs fetuses studied ranged in age between 18 to 34 WPC, weighted between 170 and 2325 g, and had CRL between 13 and 34 cm (**Table 1**). Of the 17 fetuses, 4 (23.4%) presented some kind of anomaly of the urogenital system. The **Table 2** shows the relation among the anomaly, the side affected and the fetus' age.

Renal anomalies were found in three fetuses (17.6%). Unilateral renal agenesis was found in 18 WPC fetus; pelvic kidney was found in a 19 WPC fetus and a rotation anomaly was found in a female fetus with 25 WPC (**Figures 2(a)-(c)**). In a fetus with 21 WPC we observed a duplication of the left ureter (**Figure 2(d)**). We do not observe anomalies in genital organs in this sample.

4. Discussion

The overall incidence of neural tube defects is variable in literature with incidence between 1 to 6/1000 births [1]-[17]-[19]. We studied more than 300 fetuses and find NTDs in 5.31% of the cases. In our sample we do not find cases of spina bifida isolated, a kind of anomaly very common in others studies [17]-[19].

The most frequent genitourinary anomalies are renal, testicular and urethral, respectively [20] [21]. About 10%



Figure 1. Fetuses with neural tube defects. (a) Anencephalic female fetuses with 25 WPC in anterior view; (b) Anencephalic female fetuses with 25WPC in posterior view; (c) Anencephalic female fetus with 28 WPC in a posterior view. We can observe the spina bifida associated with the anencephaly; (d) Male fetuses with 33 WPC with cephalocele in anterior view. WPC—weeks post conception.

of the population has some kind of genital or urinary system anomaly [22]. Knowledge about the incidence of anomalies in fetus with NTDs could be important for transplantation and tissue-engineered researches. In the literature we observed some papers that studied anomalies in NTDs, but these studies analyzed several kinds of anomalies [2] [23]. The present paper studied only the urogenital anomalies in fetuses with NTDs.

We studied only 17 fetuses with neural tube defects (16 with anencephaly and 1 with cephalocele), but this is one of the greatest fetal samples studied in literature about this kind of neural tube defect. In our sample we observed 23.4% of urogenital anomalies in NTDs fetuses a number very different from the 5% of anomalies found in the past in male fetuses with no evidence of congenital malformations [11]. In a previous study with 59 fetuses with cranioschisis, 13 cases (22%) of urogenital anomalies were found, but in this sample, 8 cases were cystic kidneys [2].

The anomalies of the urinary tract are frequent and correspond to 1/3 of all congenital malformations [20]-[22]. The renal agenesis is one of the most frequent renal anomalies and has an incidence of between 1/200 and 1/4000 births [20] [21]. The renal agenesis is more common in men and happens on the left side [20] [21]. We found only 1 case (5.8%) of renal agenesis, a female fetuses with 18 WPC on the right side.

Table 1. The table shows the age and the fetal parameters in anencephalic fetuses. The fetuses studied ranged in age between 18 to 22 WPC, weighted between 170 and 420 g, and had crown-rump length between 13 and 16.5 cm. M = Male; F = Female; WPC = age in weeks post-conception, g = grams; CRL = crown-rump length; cm = centimeters.

AGE (WPC)	SEX	WEIGHT (g)	LENGHT (cm)	CRL (cm)
18	F	265	22	13
18.8	F	170	22.5	14
18.9	F	230	22	14
19	M	230	22	14
19	M	280	23	14.5
19.3	F	245	24	14
19.6	F	330	24	14.5
19.6	M	280	21.5	14
20.1	F	280	23	14.5
20.2	M	340	26	16.5
21.2	M	420	26.4	15.5
21.2	F	320	25	14.5
21.9	M	340	26.5	16.5
25.6	F	810	27	18
28.4	F	850	33	20
31.4	M	1420	37	31.4
34.7	M	2325	52	34

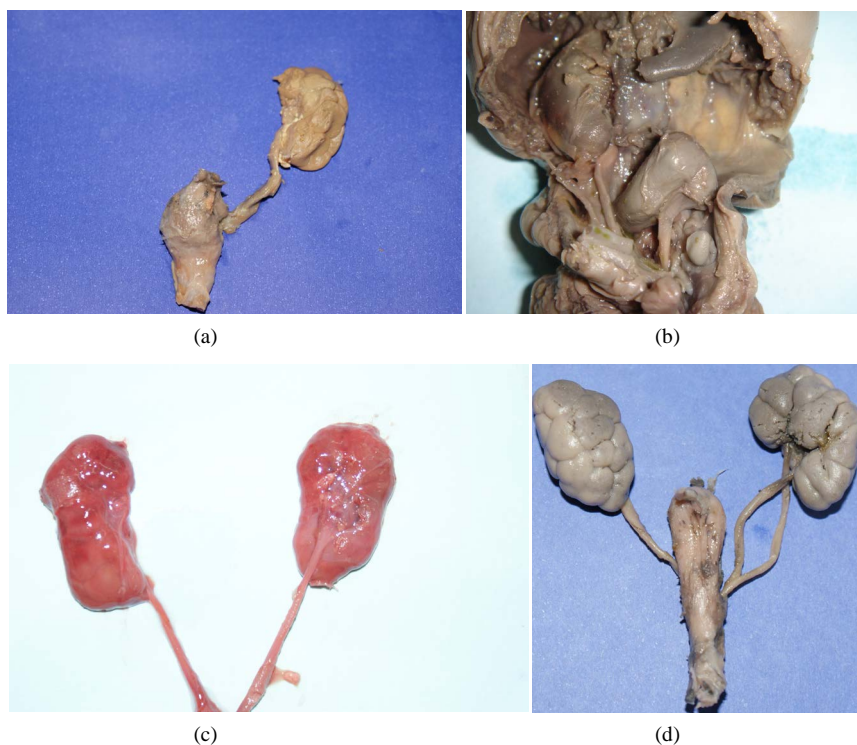


Figure 2. Urogenital anomalies in fetuses with Neural tube defects. (a) Female fetus with 18WPC with renal agenesis in right side; (b) Male fetus with 19WPC with pelvic kidney in left side; (c) Female fetus with 25WPC with renal anomaly of rotation in the left side, we can observe the renal pelvis rotated in more anterior position; (d) Female fetus with 21 WPC with a duplication of the left ureter. WPC—weeks post conception.

Table 2. The table shows the frequency distribution of anomalies in the sample. WPC = weeks post-conception.

ANOMALY	AGE	SEX	SIDE
Renal agenesis	18 WPC	Female	Right
Renal ascension	19 WPC	Male	Left
Ureteral duplication	21 WPC	Female	Right
Renal rotation	25 WPC	Female	Left

We observed only 1 case of pelvic kidney and one case of renal anomaly of rotation among the 17 fetuses with NTDs analyzed. Simple renalectopia varies in autopsy series from 1 to 1200 [20] and the pelvic kidney is one of the most rare ectopic anomalies. Renal anomalies of rotation have the incidence from 1 to 1000 and the renal pelvis situated in ventral position is the most common form of this kind of anomaly. A previous study with a great number of fetuses with neural tube defects observed only 1 case of pelvic kidney and 1 case of renal agenesis [2].

The incidence of ureteral duplication varies from 1 to 300 [21] with a female-to-male ratio of 1.6:1 and unilateral duplication is about six times more often than bilateral. In our sample we observed only one case (5.8%) of ureteral duplication in a 21 WPC female fetus in the left side. This is the first case of ureteral duplication reported in fetuses with NTDs. We do not observe anomalies in genital organs in this sample but a previous study [2] show one case of unilateral testicular agenesis and 1 case of urethral atresia in fetus with NTDs.

5. Conclusion

We concluded that the urogenital anomalies in human fetuses with NTDs are significant with an incidence superior a 20%. In this study we do not found severe urogenital anomaly that causes damage of the body function.

Conflict of Interest Statement

None declared.

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