Mohamed Ahmed Mostafa AboEllail, Kenji Kanenishi, Nobuhiro Mori, Junko Noguchi, Genzo Marumo and Toshiyuki Hata*

Ultrasound study of fetal movements in singleton and twin pregnancies at 12–19 weeks

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Abstract

Objective: To evaluate fetal behavioral differences between singleton and twin fetuses before 20 weeks of gestation using four-dimensional (4D) ultrasound.

Methods: 4D ultrasound was used to examine fetal movements in 58 singleton and 48 twin normal fetuses at 12–19 weeks. The frequencies of eight fetal movements were assessed through 15-min recordings. The fetuses were divided into two gestational age groups (12–13 and 14–19 weeks) to evaluate the changes with advancing gestation in twin versus singleton fetuses.

Results: Arm and general movements were the most frequent movements in singleton fetuses, whereas only general movement was significantly more frequent than the other seven fetal movements in twin fetuses at 12–13 weeks. At 14–19 weeks, frequencies of arm and leg movements were significantly higher than those of the other six movements in singleton fetuses, while only arm movement was significantly more frequent than the other fetal movements in twin fetuses. Comparisons of fetal movements between singleton and twin fetuses revealed that only arm movement showed a significant difference at 12–13 weeks, while the frequencies of all movements in singleton fetuses were significantly higher than those in twin fetuses at 14–19 weeks.

Conclusion: Our results suggest that the limitation of available space and crowding of twin fetuses with advancing gestation may have a marked impact on twin fetal movements compared with singleton fetuses, even in the first half of pregnancy. Further studies are needed to assess whether decreased fetal movements in twin pregnancy can affect fetal and neonatal development and maturation before and after birth.

Keywords: 4D ultrasound; fetal behavior; first half of pregnancy; singleton pregnancy; twin pregnancy.

Introduction

Twin pregnancy is associated with multiple maternal and fetal risks [1–5]. Prematurity and fetal growth restriction (FGR) are well-known fetal morbidities associated with twins [6]. Neurological abnormalities have also been linked to twin pregnancies, especially in preterm and low-birth weight twins [7]. Cerebral palsy is associated with a higher incidence in twin pregnancies compared with singleton pregnancies [8–15]. Therefore, studies on twin neurobehavior and neurological development are important to comprehensively evaluate the possible developmental mechanisms of these neurological morbidities in twin pregnancies.

Four-dimensional (4D) ultrasound has been widely used to assess fetal neurobehavior, based on the observation of fetal movements and facial expressions [16–25]. This technique is a fundamental method to assess fetal movements in utero, especially in twins, as two-dimensional (2D) sonography cannot provide a simultaneous panoramic display of twin fetuses sufficient enough to evaluate their movements. There have been several studies on the 4D ultrasound assessment of fetal twins’ spontaneous and reactive movements [26–31]. However, to the best of our knowledge, no study on 4D ultrasound assessment of the difference in the frequency of fetal movements between singleton and twin fetuses in the first half of pregnancy has been conducted. The aim of the present study was to evaluate the frequency of fetal movements in singleton and twin fetuses at 12–19 weeks of gestation, and to assess fetal behavioral differences between singleton and twin fetuses using 4D ultrasound.

*Corresponding author: Toshiyuki Hata, MD, PhD, Department of Perinatology and Gynecology, Kagawa University Graduate School of Medicine, 1750-1 Ikenobe, Miki, Kagawa 761-0793, Japan, Tel.: +81-(0)87-891-2174, Fax: +81-(0)87-891-2175, E-mail: toshi28@med.kagawa-u.ac.jp
Mohamed Ahmed Mostafa AboEllail, Kenji Kanenishi and Nobuhiro Mori: Department of Perinatology and Gynecology, Kagawa University Graduate School of Medicine, Miki, Kagawa, Japan
Junko Noguchi: Department of Nursing, Kagawa Prefectural College of Health Sciences, Takamatsu, Kagawa, Japan
Genzo Marumo: Department of Obstetrics and Gynecology, Marumo Ladies Clinic, Minato-ku, Tokyo, Japan
Materials and methods

The study population was recruited from pregnant women attending the outpatient clinic of Kagawa University Hospital for antenatal care. Healthy pregnant non-smokers with gestational ages from 12 to 19 weeks were asked to participate in the study. Fifty-eight singleton and 25 twin (13 dichorionic diamniotic (DD) and 12 monoclonial diamniotic (MD) twins) pregnancies were included. Pregnancies with maternal or fetal risk (hypertension, gestational diabetes, FGR, threatened preterm labor, polyhydramnios and chromosomal abnormalities) were not enrolled. These risk factors were excluded based on clinical examinations and maternal records.

The gestational age was calculated from the first reliable day of the last menstrual period, and confirmed by the first-trimester or early second-trimester 2D sonographic examination. All pregnancies were only examined once. The growth of all fetuses was normal, and there were no abnormalities on conducting 4D ultrasound examination. No neonate was found to have congenital anomalies or genetic disorders.

All examinations were performed using Voluson E8 (GE Healthcare Japan, Tokyo, Japan) with a curved array trans-abdominal transducer (1–4 MHz). For the accurate evaluation of fetal movements, a full panoramic view of the fetuses with clear demonstration of the fetal faces was the target. All examinations lasted 15 min, and were recorded on a 4-GB USB connected to the ultrasound machine. A quiet, temperature-controlled room was used as the venue for the examinations, which were conducted in the morning. No mechanical or acoustic stimulation was used during acquisition of the images.

Examinations and data analysis were performed by one experienced examiner (M.A.M.A.). The study was conducted following approval by the Ethics Committee of Kagawa University Graduate School of Medicine. All participants provided informed consent after a full explanation of the study objectives.

One hundred and six fetuses of 83 pregnant women (58 with a singleton pregnancy and 25 with twin pregnancies) were eligible to be enrolled in the study. Two fetuses in two twin pregnancies (one DD at 14 weeks and one MD at 18 weeks and 6 days) were excluded because of the inability to obtain a clear view of fetal movements. The remaining eligible cases were divided into an early gestation group (12–13 weeks) and a later gestation group (14–19 weeks) in both singleton and twin fetuses. The first group included 21 singleton fetuses and 14 twin fetuses (two MD and five DD twin pregnancies). The second group had 37 singleton fetuses and 34 twin fetuses (10 MD and 8 DD twin pregnancies, where each group had an excluded fetus because of their unclear visualization).

As described in detail in our previous study [32], eight fetal movements (head anteflexion, head retroflexion, body rotation, hand to face movement, general movement, arm movement, leg movement and mouthing) were assessed. Good intra- and inter-class correlation coefficients and intra- and inter-observer agreements were also confirmed in that investigation [32]. The frequencies of each movement are expressed as the median and range. Kruskal-Wallis one-way analysis of variance (ANOVA) by ranks and multiple comparisons were used to compare the frequency of different movements at 12–13 and 14–19 weeks’ gestation in singleton and twin fetuses. The frequency of each movement between singleton and twin fetuses at 12–13 and 14–19 weeks’ gestation was compared using the Mann-Whitney test.

Results

Arm (median: 4; range: 0–6) and general (median: 3; range: 1–7) movements were the most frequent movements in singleton fetuses (Figure 1), whereas only general movement (median: 3; range: 2–4) was significantly more frequent than the other seven fetal movements in twin fetuses at 12–13 weeks (Figure 2). Comparisons of fetal movements between singleton and twin fetuses revealed that only arm movement showed a significant difference at 12–13 weeks (Figure 3).

At 14–19 weeks of gestation, frequencies of arm (median: 6; range: 0–19) and leg (median: 5; range: 0–15) movements were significantly higher than those of the other six movements in singleton fetuses (Figure 4), while only arm movement (median: 2; range: 0–7) was significantly more frequent than the other fetal movements in twin fetuses (Figure 5). The frequencies of all movements in singleton fetuses were significantly higher than those in twin fetuses at 14–19 weeks (Figure 6).

Discussion

Kurjak et al. [21] found that the frequencies of general and isolated arm movements assessed by 4D ultrasound in singleton fetuses were increasing with advancing gestation between 7 and 14 weeks’ gestation, whereas the frequency of startle movement was constant during this period. Using 4D ultrasound, Hata et al. [33] reported that jumping movement (startle) was the most frequent movement followed by arm movement in singleton fetuses at 12–13 weeks of gestation. Kurjak et al. [34] also identified general and arm movements in singleton fetuses as being dominant in the first trimester of pregnancy. In the present study, arm and general movements were the most frequent movements in singleton fetuses, whereas only general movement was significantly more frequent in twin fetuses at 12–13 weeks. The frequency of arm movement in twin fetuses was significantly lower than that in singleton fetuses. The reason for the difference in the frequency of arm movement between singleton and twin fetuses is currently unknown. One possible explanation for this difference may be the diminishing distance between twins, especially due to the increasing arm contacts between co-twin fetuses at 12–13 weeks of gestation [30]. However, the data and their interpretation should be viewed with some degree of caution because of the small number of twin fetuses studied. Further studies involving a larger sample of twin pregnancies are needed to
evaluate twin fetal movements late in the first trimester of pregnancy.

Kuno et al. [35] reported that the most active fetal behavioral pattern was an arm movement in singleton fetuses using 4D ultrasound at 14–18 weeks of gestation. Sajapala et al. [32] also found that the most frequent movement was isolated arm movement followed by leg movement in singleton fetuses at 14–19 weeks’ gestation. In

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**Figure 1:** Frequencies of singleton fetal movements at 12–13 weeks of gestation.

**Figure 2:** Frequencies of twin fetal movements at 12–13 weeks of gestation.
the present study, frequencies of arm and leg movements were significantly higher in singleton fetuses, whereas only arm movement was significantly more frequent than the other fetal movements in twin fetuses at 14–19 weeks of gestation. To the best of our knowledge, our study is the first to evaluate twin fetal behaviors using 4D ultrasound.
early in the second trimester of pregnancy. Consequently, the twin fetal behavioral pattern was almost the same as that in singleton fetuses at 14–19 weeks of gestation. However, interestingly, when comparing fetal movements between singleton and twin fetuses, the frequencies of all eight movements in singleton fetuses were significantly higher than those in twin fetuses at 14–19 weeks. One possible explanation for these differences is the limitation in available space in utero and crowding of twin fetuses with advancing gestation in twin pregnancies. It is considered that the restricted space in the womb due to its sharing by co-twins affects the frequency of movements as well as the kind of predominant movement, resulting in a lower incidence of general movements and body
rotations, with more frequent arm and leg movements. The relative association between the fetal size and available space represents one of the biomechanical factors reported to affect the frequencies of fetal movements in utero [36]. We cannot speculate on whether decreased fetal movements in twin pregnancy before 20 weeks of gestation can affect the fetal and neonatal development and maturation before and after birth. Bodeau-Livinec et al. [37] reported that very preterm twins show no difference regarding severe deficiencies, but do show slightly lower cognitive scores at 5 years of age than singletons. Further studies are needed to clarify the influence of decreased fetal movements in twin pregnancy on future fetal and neonatal development and maturation before and after birth.

Author's statement
Conflict of interest: Authors state no conflict of interest.
Material and methods: Informed consent: Informed consent has been obtained from all individuals included in this study.
Ethical approval: The research related to human subject use has complied with all the relevant national regulations, and institutional policies, and is in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors’ institutional review board or equivalent committee.

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