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REVIEW ARTICLE

Maternal-Fetal Bonding: Ultrasound Imaging's Role in enhancing This Important Relationship

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ABSTRACT

New technology in ultrasound imaging is allowing women to view more visually precise images of their fetuses than ever before. Maternal-fetal bonding describes the attachment interaction that forms between a mother and her unborn child. Ultrasound diagnosis modalities including two-dimensional (2D), three-dimensional (3D) and four-dimensional (4D) may create differences in the amount of maternal-fetal bonding, depending on the modality used. When relevant literature was reviewed on this topic, no significant difference between maternal-fetal bonding was found when comparing 2D *vs* 3D *vs* 4D ultrasound. However, certain measures such as a perceived feeling of closeness to the baby were higher with 3D and 4D ultrasounds as compared with 2D ultrasound. Further exploration is needed to ascertain whether different ultrasound modalities have an effect on maternal-fetal bonding in multigestational pregnancies, pregnancies in which there is fetal demise, and to overall examine the effects of using ultrasound for nonmedical 'entertainment' purposes by prospective mothers.

Keywords: Maternal-fetal bonding, Two-dimensional ultrasound, Three-dimensional ultrasound, Four-dimensional ultrasound, Attachment.

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INTRODUCTION

Advances in ultrasound imaging technology are allowing women visually-precise glimpses of their babies months before delivery. The function of these imaging modalities including two-dimensional (2D), three-dimensional (3D) and four-dimensional (4D) ultrasound is three-fold. Not only are such advances in ultrasound technology allowing expectant mothers to see details of their baby's physique, but also such modalities allow a better visual understanding of the fetal structures and growth. Ultrasound imaging is also able to aid physicians in early diagnosis of birth defects and abnormalities. Maternal-fetal bonding is a complex interaction which begins prenatally and past studies been shown to increase, when the expectant mother is able to see ultrasound images of her fetus before birth.[1] While ultrasound has traditionally been used in evaluating pregnancies, the question remains: does a 2D *vs* 3D or even 4D ultrasound affect this maternal-fetal bonding relationship? Health care professionals need to understand the important relationships between 2D, 3D and 4D ultrasound imaging modalities, as these can be used to potentially nurture the psychological relationship between the expecting parents and the fetus.

MATERNAL-FETAL BONDING

The significance of the relationship between mother and fetus is called 'prenatal attachment'. Further defined by Cranley in 1981, maternal fetal attachment (MFA) is 'the extent to which women engage in behaviors that represent an affiliation and interaction with their unborn child'.[2]

Maternal-fetal attachment is positively influenced by many factors including the mother's state of mind, surroundings and environment, social support system, as well as negatively influenced by factors, such as substance abuse and anxiety.[2]

Prenatal studies have been shown to be powerful tools in nurturing the MFA between an expectant mother and her unborn fetus. While there has been little difference on the MFA in visual prenatal studies such as ultrasound *vs* nonvisual studies, it is important to recognize the positive effects a prenatal ultrasound can have on this important relationship.[1] Ultrasound has been shown to give parents a confirmation of a new life, through two components: ultrasound provides a visualization of the baby, and a realization that the unit will soon become a family. Ultrasound is also known to be a reassuring tool, showing that the life-form carried inside the expectant mother is indeed a baby.[3] It has been shown that ultrasound decreases maternal partaking in risky behaviors during pregnancy, such as alcohol intake.[4] Such positive attributes of ultrasound in pregnancy should not be overlooked. The bond that has been shown to start before birth of the baby is enhanced when the mother can be aware of the growing baby inside her.[1]

One expectant mother remarks that, '…there actually is something so almost completely developed it just has to grow. That such good technology exists—it's unbelievable…they can see so much'.[3] Whatever, the draw for a mother to desire to see her fetus, there is no denying that ultrasound techniques in the obstetric field can be powerful in enhancing and shaping the maternal-fetal bonding and attachment that is underway.

OVERVIEW OF 2D, 3D AND 4D ULTRASOUND MODALITIES ON MATERNAL-FETAL BONDING

Currently, 2D, 3D and 4D ultrasound modalities can be offered to expectant mothers for imaging. Much research has gone into the development of theories regarding which ultrasound technique is most effective in nurturing and enhancing MFA.

Despite the fact that the most basic ultrasound, 2D, cannot show surface rendering and definite physique as 3D imaging, as 3D allows multiplanar evaluation, and assessment of spatial, and volumetric relationships,[5] there has been little difference shown between the relationship or feelings expressed by the expectant mother after viewing their baby on a 2D *vs* 3D ultrasound. Mothers and fathers found both imaging modalities helpful in knowing that baby was real and healthy.[6] However, one study shows that 82% of mothers would chose 3D ultrasound over 2D ultrasound because of the sense of closeness they feel due to the enhanced images.[7]

2D ultrasound can be difficult for the mother and father to interpret and understand. However, 3D ultrasound provides clear imaging of important anatomical landmarks such as the skull and face.[6] It has also been shown that families can experience some disappointment with 3D ultrasound, as the imaging's capabilities may leave them disappointed with the quality of 3D images they receive.[7] One study gave women a 2D ultrasound followed by a 3D ultrasound weeks later. There was found to be no difference between the bonding. It has been suggested that this lack of difference can be attributed to the 'ceiling effect' of a 2D ultrasound. By the time the mother has experienced a 2D ultrasound, she has already maximally felt bonding and attachment.[4]

3D ultrasound has been shown to more positive effect the parents' enthusiasm over the pregnancy, especially in social situations (showing off the 3D images to the family and friends, etc.).[7,8] 3D ultrasound has been very popular in the media, as the fetal face can be very closely identified.[9] Leung et al[8] assessed 124 women attending prenatal ultrasound clinic.[8] Maternal anxiety levels were compared between two groups of patients (intervention group, in which 2D ultrasound was followed by 3D ultrasound, and control group, in which 2D ultrasound alone was performed) at patient's first visit, 18 and 28 weeks' gestation. This study demonstrated a short-term reduction of the anxiety score after the first visit, and no significant difference between the groups. However, about 80% of women reported being able to tell that the baby was more real in 3D ultrasound over 2D ultrasound.[8]

In comparing 2D and 4D ultrasound fathers have experienced more bonding with their future babies with 4D ultrasound. Paternal attachment even decreased after viewing a 2D ultrasound, whereas it inevitably increased after viewing a 4D ultrasound. However, maternal attachment was always shown to increase after 4D and 2D ultrasound.[10] It has been suggested that men are more concerned with the technique.[3] Perhaps men are more visually stimulated by high-tech and detailed graphics. Fathers have also been shown to be more excited about the prospects of 3D ultrasound over 2D.[11]

Tables 1 and 2 demonstrate ultrasound characteristics and comparison between 2D, 3D and 4D ultrasound in MFA. Overall, ultrasound imaging was shown to be 'less real' for women who had yet to feel quickening or movement of the baby. Women in their second pregnancy were able to appreciate ultrasound more as showing a 'real' baby, as they have previously experienced all sensations associated with

Table 1: Ultrasound imaging characteristics in maternal-fetal attachment

Imaging modality	*Image quality, limitations and advantages*	*Maternal preference*	*Paternal preference*
2D US	JI et al[6]—difficult to understand image	Sedgmen et al[4] suggest 'ceiling effect' after 2D US for mothers	Righetti et al[10]—attachment has actually decreased after 2D US
3D US	Timor-Tritsch and Platt[5]—multiplanar evaluation, spatial and volumetric relationships JI et al[6] allow physicians and patients to see facial features Goncalves et al[10] popular due to the ability to see facial features	JI et al[6]—mothers had higher expectations that were not met; overall more enthusiastic feelings	JI et al[6]—overall more enthusiastic feelings toward fetus
4D US			Righetti et al[10]—paternal attachment has increased after 4D US

2D: Two-dimensional; 3D: Three-dimensional; 4D: Four-dimensional; US: Ultrasound

Table 2: Two-dimensional *vs* three-dimensional *vs* four-dimensional ultrasound imaging comparisons in maternal-fetal attachments

2D vs 4D ultrasound
Lapaire et al[7]—82% of expectant mothers preferred 3D over 2D due to 'closeness'; however, there was no difference between relationship and expressed feelings
Sedgmen et al[4]—no difference between the two; perhaps 2D ultrasound has 'ceiling effect.'
JI et al[6]—both are helpful in helping mothers feel close and experience the reality of their baby; parents were found to be more excited to show off 3D US images.
Leung et al[8]—80% of women had better understanding that their baby was 'normal' with 3D over 2D US
2D vs 4D ultrasound
Righetti et al[10]—little difference between the two ultrasound modalities. Mothers had increased MFA with 2D and 4D. Father's felt decreased attachment after 2D but increased after 4D US
3D vs 4D ultrasound
Pretorius et al[11]—both 3D and 4D US have positive change in parent's feelings toward the fetus
2D vs 3D/4D ultrasound
Leung et al[8]—at risk pregnancies did not have decreased anxiety with 3D/4D ultrasound compared with 2D. A total of 80% of women thought that following 3D/4D US, they had better understanding that their baby was normal

2D: Two-dimensional; 3D: Three-dimensional; 4D: Four-dimensional; MFA: Maternal-fetal attachment; US: Ultrasound

pregnancy. Fathers and mothers alike have remarked that after ultrasound imaging they feel more like parents. One woman even remarked that her partner acted more gentle and kind toward her after ultrasound imaging.[3]

Many have been concerned over the morality of ultrasound. Does entertaining the mother and father with images of their baby outweigh the risks of finding fetal abnormalities? Could ultrasound even cause more abortions? Is ultrasound a 'weapon of morality'?[12] It is important that parents be well-informed about the potential implications of ultrasound in medical diagnosis. Educating parents can help reduce possible shock associated with identifying fetal abnormalities and/or other adverse outcomes.[13]

CONCLUSION

Maternal-fetal bonding is a very complex concept that at its simplest describes the emotional attachment between an expectant mother and her growing fetus. There are many components that contribute to parental bonding, which include environmental factors, such as social support and prenatal screening. It seems that 3D and 4D ultrasound may change the parental attitude toward pregnancy and may contribute to an increase in bonding to fetus. While studies have not shown any explicit difference in the level of bonding with the use of 2D *vs* 3D *vs* 4D ultrasound, after reviewing the effects of various types of ultrasound on maternal-fetal bonding, it is evident that there is a wide range of associated topics that may prove fruitful if further explored. These topics include examining the effects of different ultrasound modalities in multiple pregnancies and the effects of different ultrasound modalities in instances of fetal demise. Some findings suggest that experiencing a miscarriage in a previous pregnancy does not necessarily affect a woman's psychological mindset in a following pregnancy.[14] However, examining the role of various ultrasound modalities in pregnancies in which fetal demise occurs is warranted, as the type of ultrasound may impact maternal perception to varying degrees during a subsequent pregnancy. Examining the role of different ultrasound modalities and the effect they may have on maternal-fetal bonding in multiple pregnancies is also warranted. For instance, one study suggested that mothers felt more attachment to twin B in a twin pregnancy as twin B may be easier to see or touch.[16] By comparing 2D *vs* 3D *vs* 4D ultrasound, we may be able to ascertain if these disparate ultrasound types may favor equal MFA among fetuses in multiple pregnancies, may favor increased MFA to one of the fetuses, or may change the quality or characteristics of MFA as a whole.

Additionally, previous research has found that higher maternal education levels correlated with larger head growth.[15] More research is warranted in examining, if maternal prenatal education (including the effect of ultrasound different types of ultrasound) has any correlation to both physical and psychological factors involving the fetus. In some areas and in certain demographics, 3D and 4D ultrasounds have become largely employed for nonmedical entertainment reasons, i.e. 'boutique' ultrasounds that parents desire as keepsakes.[17] According to one study, no significant harm has been found in children who had multiple prenatal ultrasounds, as compared with children who had minimal ultrasound imaging prior to birth.[18] However, the use of 3D and 4D ultrasounds for

nonmedical purposes remains controversial. Further research is warranted on whether mothers who have been screened using different ultrasound modalities have different attitudes toward their fetuses, their health and future pregnancies.

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