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Prenatal Detection of Upper Limb Differences with Obstetric Ultrasound

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Abstract

Purpose—To determine the sensitivity, specificity, and predictive values of prenatal ultrasound detection of fetal upper extremity anomalies at a single tertiary care center in a large patient cohort. Our secondary purpose was to assess factors affecting prenatal detection including the presence of associated anomalies.

Methods—We performed a retrospective review of prenatal ultrasound and postnatal clinical records from each pregnancy evaluated with a prenatal ultrasound at the *BLINDED* Washington University Department of Obstetrics and Gynecology over a 20-year period. We searched for upper extremity anomaly diagnosis codes pre- and postnatally and correlated with clinical postnatal follow up to determine prevalence, sensitivity, specificity, predictive values, and associated conditions.

Results—A total of 100,856 pregnancies were evaluated by prenatal ultrasound, which included 843 fetuses diagnosed with a musculoskeletal anomaly (prevalence 1/120) and 642 with an upper extremity anomaly (prevalence 1/157). The postnatally confirmed sensitivity for prenatal ultrasound detection of an upper extremity anomaly was 42%. Sensitivity was lower in cases isolated to the upper extremity (25% vs 55%). Sensitivity was highest for conditions affecting the entire upper extremity (70–100%) and lowest for those affecting the digits alone (4–19%). Fetuses with limb reduction defects, radial longitudinal deficiency, phocomelia, arthrogryposis, abnormal hand positioning, and cleft hand had a higher likelihood of having an associated anomaly.

Conclusions—At our tertiary referral center, there was a notable prevalence of upper extremity anomalies, however the overall sensitivity for detecting them with prenatal ultrasound was low. This was disappointing given the value of prenatal identification of anomalies for parental

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counseling. Prenatal diagnosis of anomalies affecting the entire upper limb was more reliable than diagnosis of more distal anomalies.

Level of Evidence—III - Diagnostic

Keywords

Congenital limb anomaly; Prenatal detection; Prenatal obstetric ultrasound; Birth anomaly; Gestation

Introduction

Prenatal detection and diagnosis of upper limb anomalies provides an opportunity for parental counseling and may prompt earlier diagnosis and treatment of associated conditions. Ultrasound remains the primary modality for fetal evaluation, [1] and detection of fetal anomalies has improved substantially over the last several decades as a result of technological advances, improved resolution, standardization of prenatal ultrasound protocols, and training of diagnosticians. [2–7] Recent studies have shown the sensitivity for detection of major fetal anomalies to be over seventy percent, although the detection of musculoskeletal anomalies remains lower, ranging from eighteen to forty percent. [6,8] Evaluation of the upper extremity, especially the small structures of the hand, can be difficult, with sensitivities between twenty and thirty percent. [2,7,9] Detection rates tend to be higher in tertiary care centers, for high-risk patients, and for fetuses with multiple anomalies. [8]

The aims of this study were to evaluate the performance of prenatal ultrasound detection of fetal upper limb defects at a single tertiary care center, to determine which upper limb defects were the most and least likely to be diagnosed prenatally, to understand relative frequency of upper extremity anomalies, and to determine if upper extremity anomalies with concomitant associated conditions had higher detection rates.

Materials and Methods

After approval by the human research protection office at *BLINDED*Washington University School of Medicine, we performed a retrospective review of all pregnancies evaluated with a prenatal ultrasound at the *BLINDED*Washington University Department of Obstetrics and Gynecology between January 1990 and January 2010. This is a tertiary referral center that provides care to both high and low risk pregnant women and performs both standard and specialized obstetric ultrasound examinations. Registered diagnostic medical sonographers with certification in obstetrics & gynecology performed the examinations, and maternal-fetal medicine specialists interpreted them. A dedicated nurse coordinator acquired postnatal clinical follow up data on 94% of births, allowing for validation of prenatal ultrasound findings and identification of anomalies not diagnosed by ultrasound (false negatives).

The Department of Obstetrics & Gynecology database includes all pregnancies with prenatal or postnatal diagnoses of any anomaly. This database contains indications for the ultrasound,

musculoskeletal anomaly (prevalence of 1/120). There were 642 fetuses with a postnatally confirmed upper extremity anomaly, providing a prevalence of 1/157 in this population. The overall prevalence of each upper extremity anomaly in this population, as well as the prevalence in the high-risk and low risk pregnancy groups, is shown in Table 1.

Overall sensitivity for detection of a fetal upper extremity anomaly was 42% (confidence interval 38–46%). Table 2 shows the sensitivity (with confidence intervals), specificity and predictive values of prenatal ultrasound detection of each upper extremity anomaly diagnosis. Sensitivity of anomaly detection was highest for conditions affecting the entire upper extremity and lowest for those affecting the digits alone. Limb reduction defects were divided into limb versus digital anomalies, and a lower sensitivity was found for digit (24%) compared to the limb (76%). The highest rate of false positive results was in abnormal hand positioning, leading to a poorer positive predictive value (84%). Overall sensitivity was higher in cases with associated compared to isolated cases, and this was also true within each diagnosis.

Of the pregnancies with a diagnosed fetal musculoskeletal anomaly, 350 (42%) were considered high-risk. For 3 types of limb anomalies, more than fifty percent of pregnancies were high-risk: phocomelia (80%), amniotic constriction bands (59%), and abnormal hand positioning (53%). In all other diagnoses, less than fifty percent of fetuses were part of a high-risk pregnancy (the lowest being ulnar longitudinal deficiency at 11%), indicating that no anomaly was suspected at the first ultrasound at our center. In general, more fetuses with an associated diagnosis were a product of a high-risk pregnancy than fetuses with an isolated upper extremity anomaly (see Appendix).

Approximately 40% of fetuses with abnormal hand positioning, arthrogryposis, and phocomelia resulted in stillbirth or neonatal death compared to less than 20% for all other diagnoses. Pregnancies in which the fetus had multiple anomalies were terminated 8.5 times more often than those with an isolated upper extremity anomaly.

Over fifty percent of fetuses with a diagnosis of phocomelia (100%), abnormal hand positioning (89%), radial longitudinal deficiency (81%), arthrogryposis (67%), cleft hand (60%), and limb reduction defect (58%) had an associated anomaly confirmed on prenatal ultrasound, while in other diagnoses, associated anomalies were uncommon, including symbrachydactyly (20%), polydactyly (24%), ulnar longitudinal deficiency (33%), syndactyly (42%), and amniotic band syndrome (45%). Patients with upper extremity anomalies with associated conditions did not consistently have more ultrasound examinations performed than patients with isolated anomalies, nor were they consistently detected at an earlier gestational age. Instead these relationships varied with each diagnosis (see Appendix).

For each upper extremity diagnosis, associated conditions involving other organ systems are listed in Table 3, and associated syndromes and chromosomal abnormalities are listed in Table 4. Fetuses with radial longitudinal deficiency more commonly had multiple organ system involvement, hypoplastic thumb, and VACTERL. Fetuses with polydactyly and syndactyly had a large variety of other conditions involving other organ systems and

syndromes. Fetuses with abnormal hand positioning more commonly had aneuploidy, especially trisomy 18, and facial anomalies. 60% of fetuses with cleft hand also had cleft foot. Ulnar longitudinal deficiency and symbrachydactyly had the lowest involvement of other organ systems.

Discussion

The sensitivity of prenatal ultrasound for detection of musculoskeletal and limb anomalies has been low historically. In 1991, Levi published a series of 16,072 pregnant women with prenatal ultrasound and found a 40% sensitivity for detection of any type of anomaly, with a 17% sensitivity for detection of limb and skeletal anomalies. [2] In 1992, Stoll found a 15% sensitivity for isolated anomalies and 48% sensitivity for multiple anomalies for second trimester prenatal ultrasounds. [3] Detection of major anomalies has improved over the last two decades as a result of improvements in technology and technique, although detection of limb anomalies remains low. The Eurofetus study, in 1999, showed an overall sensitivity for detection of any anomaly to be 61%, with identification of musculoskeletal anomalies much lower and similar to the findings of Levi, et al at 18%. [4]

More recent studies have shown improved detection of upper extremity anomalies, with more accurate diagnosis in the presence of associated anomalies and conditions involving the entire limb. The 2005 EUROCAT study of 4,366 fetuses with anomalies found a prenatal detection rate for both upper and lower limb reduction defects of 34%. [6] Stoll et al found a higher prenatal detection rate for limb reduction defects with associated malformations (49%) compared to isolated limb reduction defects (25%), and Pakjrt et al found a high detection rate for fetuses with short or absent radii and/or ulnae with associated aneuploidy or genetic syndromes (70%). [10,11] Stoll et al also found previously that detection of more proximal limb reduction defects was better (23–50%) than detection of hand or finger limb reduction defects (0–8%). [12] Gray et al found that 31% of upper extremity anomalies were detected prenatally, however only 18% were correctly diagnosed. [7] Those that were missed tended to involve the hand and fingers more than the forearm or entire upper extremity. Our overall detection sensitivity of 42%, with higher sensitivity in fetuses with associated conditions and more proximal involvement, is better than these previously published reports. Our sensitivity for more proximal anomalies was markedly improved compared to prior studies, ranging from 75–100%.

Suboptimal detection of upper extremity anomalies is related to several factors; the current fetal imaging guidelines mandate only a cursory examination of the upper and lower limbs during the standard second trimester examination, which may contribute to a high false negative rate. [13] The ideal window for visualizing the fetal hands is at the late first and early second trimester, when the fingers tend to be extended and abducted; ultrasound examinations at a later gestational age are limited by fetal size, position, and flexed digits. [9] The use of three-dimensional ultrasound has also been shown to improve detection of hand anomalies by as much as 50%, [7,9,14] however is not currently recommended for routine use by the American College of Obstetrics and Gynecology. [1,13] We did not routinely use three-dimensional imaging in our patients.

Several benefits are derived from the prenatal diagnosis of upper extremity anomalies. [15] The primary advantage is the opportunity for more refined and prognostic prenatal counseling and preparation. Parents are given the chance to discuss their child's diagnosis with a variety of specialists and receive genetic counseling. For treatable anomalies, a team may be assembled to prepare for postnatal care. Some families will consider pregnancy termination for major untreatable anomalies, and several studies have shown higher rates of pregnancy termination after early prenatal diagnosis of major untreatable anomalies. [2,5,6,12] However, conditions with a high rate of false positives should be considered with caution since they can mislead parents and clinicians in their decisions and recommendations.

The identification of an upper extremity anomaly should instigate a more detailed evaluation of the entire fetus, given the high rate of associated conditions. [11,15] Over 50% of the fetuses with limb reduction defects, phocomelia, radial longitudinal deficiency, arthrogryposis, abnormal hand positioning, and cleft hand in our study population had an associated condition involving a major organ system. Several diagnoses were also associated with a high-risk of aneuploidy (Table 4); these fetuses should be considered for diagnostic testing for aneuploidy or chromosomal microarray analysis.

The primary strength of our study was the large study population and the availability of coupled prenatal sonographic and postnatal clinical information for each pregnancy, allowing an accurate assessment of the performance of prenatal ultrasound diagnosis. We were also able to subdivide diagnoses to determine more specific sensitivity data than are available in the literature. Our data are derived from a single center with a consistent sonographic protocol, and, therefore, avoided the variability seen in multicenter studies.

This study may overestimate the sensitivity of obstetric ultrasound for prenatal diagnosis of upper extremity anomalies, as our institution is a tertiary referral center, prompting more thorough examinations. Additionally, registered diagnostic medical sonographers with certification in obstetrics and gynecology perform the exams; these are interpreted by maternal-fetal medicine specialists. These factors provide an optimal setting for prenatal identification of upper extremity anomalies. While technological advances occurred over the course of the data collection, our equipment was serially replaced and, therefore, we cannot identify which studies were performed on which machines. The small number of fetuses diagnosed with certain anomalies is a limitation of our study. Additionally, heterogeneity in gestational age at first ultrasound at our institution may have introduced bias into our sensitivity data since not all patients were evaluated during the ideal window between the late first and early second trimesters.

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TABLE 1

Prevalence of Upper Extremity Anomalies

Diagnosis	Prevalence		
	Overall	In High Risk Pregnancies	In Low Risk Pregnancies
Polydactyly	1/306	1/5	1/388
Limb Reduction Defect	1/840	1/7	1/1,500
Abnormal Hand Positioning	1/917	1/6	1/1,932
Syndactyly	1/1,201	1/13	1/1,733
Arthrogryposis	1/2,802	1/21	1/5,290
Amniotic Band Syndrome	1/4,584	1/27	1/11,167
Radial Longitudinal Deficiency	1/6,303	1/44	1/12,563
Ulnar Longitudinal Deficiency	1/11,206	1/350	1/12,563
Phocomelia	1/20,171	1/88	1/100,506
Symbrachydactyly	1/20,171	1/175	1/33,502
Cleft Hand	1/20,171	1/175	1/33,502

Note: High risk is defined as a patient referred with a known or suspected musculoskeletal anomaly

TABLE 2

Prenatal Detection by Diagnosis

Limb Reduction Defects						
	Sensitivity	CI	Specificity	PPV	NPV	
Isolated (n=50)	52%	37–66%	100%	100%	100%	
Associated (n=70)	69%	57–80%	100%	96%	100%	
Total (n=120)	62%	52–71%	100%	97%	100%	
Phocomelia						
	Sensitivity	CI	Specificity	PPV	NPV	
Isolated (n=0)	-		-	-	-	
Associated (n=5)	100%	48–100%	100%	100%	100%	
Total (n=5)	100%	48–100%	100%	100%	100%	
Radial Longitudinal Deficiency						
	Sensitivity	CI	Specificity	PPV	NPV	
Isolated (n=3)	67%	9–99%	100%	100%	100%	
Associated (n=13)	77%	46–95%	100%	100%	100%	
Total (n=16)	75%	47–93%	100%	100%	100%	
Ulnar Longitudinal Deficiency						
	Sensitivity	CI	Specificity	PPV	NPV	
Isolated (n=6)	67%	22–96%	100%	100%	100%	
Associated (n=3)	100%	30–100%	100%	100%	100%	
Total (n=9)	78%	40–97%	100%	100%	100%	
Amniotic Constriction Bands						
	Sensitivity	CI	Specificity	PPV	NPV	
Isolated (n=12)	42%	15–72%	100%	100%	100%	
Associated (n=10)	60%	30–93%	100%	86%	100%	
Total (n=22)	50%	30–74%	100%	92%	100%	
Symbrachydactyly						
	Sensitivity	CI	Specificity	PPV	NPV	
Isolated (n=4)	50%	7–93%	100%	100%	100%	

Associated (n=1)	100%	2–100%	100%	100%	100%
Total (n=5)	60%	15–95%	100%	100%	100%
Arthrogryposis					
	Sensitivity	CI	Specificity	PPV	NPV
Isolated (n=12)	92%	62–93%	100%	100%	100%
Associated (n=24)	75%	51–91%	100%	79%	100%
Total (n=36)	81%	64–93%	100%	87%	100%
Abnormal Hand Positioning					
	Sensitivity	CI	Specificity	PPV	NPV
Isolated (n=12)	67%	30–90%	100%	67%	100%
Associated (n=98)	77%	67–85%	100%	86%	100%
Total (n=110)	76%	66–84%	100%	84%	100%
Cleft Hand					
	Sensitivity	CI	Specificity	PPV	NPV
Isolated (n=2)	50%	1–99%	100%	100%	100%
Associated (n=3)	67%	9–99%	100%	100%	100%
Total (n=5)	60%	15–95%	100%	100%	100%
Syndactyly					
	Sensitivity	CI	Specificity	PPV	NPV
Isolated (n=49)	0%	0–7%	100%	0%	100%
Associated (n=35)	9%	2–23%	100%	100%	100%
Total (n=84)	4%	1–10%	100%	100%	100%
Polydactyly					
	Sensitivity	CI	Specificity	PPV	NPV
Isolated (n=250)	18%	13–23%	100%	98%	100%
Associated (n=80)	24%	15–35%	100%	82%	100%
Total (n=330)	19%	15–24%	100%	93%	100%

CI, Confidence Interval; PPV, Positive Predictive Value; NPV, Negative Predictive Value

TABLE 3

Conditions Associated with each Diagnosis

Limb Reduction Defects						
CNS	Face	Nuchal	CT	Abd	Renal	Total
22	18	5	29	22	24	120
Phocomelia						
CNS	Face	Nuchal	CT	Abd	Renal	Total
0	3	1	2	1	0	7
Radial Longitudinal Deficiency						
CNS	Face	Nuchal	CT	Abd	Renal	Total
4	4	8	11	3	6	44
Ulnar Longitudinal Deficiency						
CNS	Face	Nuchal	CT	Abd	Renal	Total
2	1	0	1	1	0	5
Amniotic Constriction Bands						
CNS	Face	Nuchal	CT	Abd	Renal	Total
6	4	0	2	3	0	15
Synbrachydactyly						
CNS	Face	Nuchal	CT	Abd	Renal	Total
1	0	0	0	0	0	1
Arthrogryposis						
CNS	Face	Nuchal	CT	Abd	Renal	Total
8	12	5	9	7	5	46
Abnormal Hand Positioning						
CNS	Face	Nuchal	CT	Abd	Renal	Total
41	50	9	27	15	17	159
Cleft Hand						
CNS	Face	Nuchal	CT	Abd	Renal	Total
1	3	0	0	0	1	8
Syndactyly						
					Cleft Foot	3

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CNS	Face	Nuchal	CT	Abd	Renal	Polydactyly	Total
7	15	1	12	7	10	6	58
Polydactyly							
CNS	Face	Nuchal	CT	Abd	Renal	Rocker Bottom Feet	Total
13	32	9	27	15	17	10	123

CNS; Central Nervous System; CT, Cardiothoracic; Abd, Abdomen

TABLE 4

Associated Syndromes and Chromosomal Anomalies

Limb Reduction Defects				
Trisomy 18				Total
4				4
Radial Longitudinal Deficiency				
VACTERL				Total
7				7
Ulnar Longitudinal Deficiency				
Trisomy 18				Total
1				1
Arthrogryposis				
Trisomy 18				Total
5				5
Abnormal Hand Positioning				
Trisomy 13	Trisomy 18			Total
5	38			43
Syndactyly				
Trisomy 18	Trisomy 21	Aperts	69 XXX	Total
4	1	1	2	8
Polydactyly				
Trisomy 18	Short Rib Polydactyly			Total
10	2			12

Appendix

Complete Data per OMT

Limb Reduction Defects												
	Indications for US		Prenatal Detection				Gestational Age at Dx		Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV	NPV	<22 wks	>22 wks	LB	TOP	STB	NND
Isolated (n=50)	19 (38%)	31 (62%)	52%	100%	100%	100%	-	-	41 (82%)	8 (16%)	1 (2%)	0
Associated (n=70)	34 (49%)	36 (51%)	69%	100%	96%	100%	-	-	22 (32%)	32 (46%)	8 (11%)	8 (11%)
Total (n=120)	53 (44%)	67 (56%)	62%	100%	97%	100%	78 (65%)	42 (35%)	63 (53%)	40 (33%)	9 (8%)	8 (6%)
Phocomelia												
	Indications for US		Prenatal Detection				Gestational Age at Dx		Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV	NPV	Average # US	<22 wks	>22 wks	LB	TOP	STB
Isolated (n=0)	0	0	-	-	-	-	0	0	0	0	0	0
Associated (n=5)	4 (80%)	1 (20%)	100%	100%	100%	100%	2.8	2 (40%)	3 (60%)	1 (20%)	2 (40%)	0
Total (n=5)	4 (80%)	1 (20%)	100%	100%	100%	100%	2.8	2 (40%)	3 (60%)	1 (20%)	2 (40%)	0
Radial Longitudinal Deficiency												
	Indications for US		Prenatal Detection				Gestational Age at Dx		Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV	NPV	Average # US	<22 wks	>22 wks	LB	TOP	STB
Isolated (n=3)	1 (33%)	2 (67%)	67%	100%	100%	100%	4	2 (67%)	1 (33%)	2 (67%)	1 (33%)	0
Associated (n=13)	7 (54%)	6 (46%)	77%	100%	100%	100%	2	9 (69%)	4 (31%)	5 (38%)	7 (54%)	1 (8%)
Total (n=16)	8 (50%)	8 (50%)	75%	100%	100%	100%	3	11 (69%)	5 (31%)	7 (44%)	8 (50%)	1 (6%)
Ulnar Longitudinal Deficiency												
	Indications for US		Prenatal Detection				Gestational Age at Dx		Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV	NPV	Average # US	<22 wks	>22 wks	LB	TOP	STB
Isolated (n=6)	1 (17%)	5 (83%)	67%	100%	100%	100%	1.8	3 (50%)	3 (50%)	5 (83%)	1 (17%)	0
Associated (n=3)	0	3 (100%)	100%	100%	100%	100%	2.7	3 (100%)	0	1 (33%)	2 (67%)	0
Total (n=9)	1 (11%)	8 (89%)	78%	100%	100%	100%	2.3	6 (67%)	3 (33%)	6 (67%)	3 (33%)	0
Amniotic Constriction Bands												
	Indications for US		Prenatal Detection				Gestational Age at Dx		Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV	NPV	Average # US	<22 wks	>22 wks	LB	TOP	STB
Isolated (n=12)	6 (50%)	6 (50%)	42%	100%	100%	100%	2.9	5 (42%)	7 (58%)	11 (92%)	0	0
												NND
												1 (8%)

Associated (n=10)	7 (70%)	3 (30%)	60%	100%	86%	100%	1.9	6 (60%)	4 (40%)	2 (20%)	5 (50%)	2 (20%)	1 (10%)
Total (n=22)	13 (59%)	9 (41%)	50%	100%	92%	100%	2.4	11 (50%)	11 (50%)	13 (59%)	5 (23%)	2 (9%)	2 (9%)
Symbrachydactyly													
	Indications for US		Prenatal Detection			Average # US	Gestational Age at Dx			Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV		<22 wks	>22 wks	LB	TOP	STB	NND	
Isolated (n=4)	2 (50%)	2 (50%)	50%	100%	100%	1.8	3 (75%)	1 (25%)	4 (100%)	0	0	0	0
Associated (n=1)	0	1 (100%)	100%	100%	100%	6	0	1 (100%)	1 (100%)	0	0	0	0
Total (n=5)	2 (40%)	3 (60%)	60%	100%	100%	3.9	3 (60%)	2 (40%)	5 (100%)	0	0	0	0
Arthrogryposis													
	Indications for US		Prenatal Detection			Gestational Age at Dx	Gestational Age at Dx			Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV		<22 wks	>22 wks	LB	TOP	STB	NND	
Isolated (n=12)	4 (25%)	8 (75%)	92%	100%	100%	-	-	-	6 (50%)	4 (33%)	1 (12.5%)	1 (12.5%)	
Associated (n=24)	13 (54%)	11 (46%)	75%	100%	79%	-	-	-	4 (17%)	8 (33%)	8 (33%)	4 (17%)	
Total (n=36)	17 (47%)	19 (53%)	81%	100%	87%	21 (58%)	15 (42%)	10 (28%)	12 (33%)	9 (25%)	5 (14%)	5 (14%)	
Abnormal Hand Positioning													
	Indications for US		Prenatal Detection			Gestational Age at Dx	Gestational Age at Dx			Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV		<22 wks	>22 wks	LB	TOP	STB	NND	
Isolated (n=12)	3 (25%)	9 (75%)	67%	100%	67%	-	-	-	6 (50%)	3 (25%)	2 (17%)	1 (8%)	
Associated (n=98)	55 (56%)	43 (44%)	77%	100%	86%	-	-	-	21 (21%)	36 (37%)	20 (20%)	21 (22%)	
Total (n=110)	58 (53%)	52 (47%)	76%	100%	84%	63 (57%)	47 (43%)	27 (24%)	39 (36%)	22 (20%)	22 (20%)	22 (20%)	
Cleft Hand													
	Indications for US		Prenatal Detection			Average # US	Gestational Age at Dx			Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV		<22 wks	>22 wks	LB	TOP	STB	NND	
Isolated (n=2)	0	2 (100%)	50%	100%	100%	3	2 (100%)	0	2 (100%)	0	0	0	0
Associated (n=3)	2 (67%)	1 (33%)	67%	100%	100%	1.3	0	3 (100%)	3 (100%)	0	0	0	0
Total (n=5)	2 (40%)	3 (60%)	60%	100%	100%	2.2	2 (40%)	3 (60%)	5 (100%)	0	0	0	0
Syndactyly													
	Indications for US		Prenatal Detection			Average # US	Gestational Age at Dx			Pregnancy Outcome			
	High Risk	Other	Sensitivity	Specificity	PPV		<22 wks	>22 wks	LB	TOP	STB	NND	
Isolated (n=49)	3 (6%)	46 (94%)	0%	100%	0%	1.8	0	49 (100%)	48 (98%)	0	1 (2%)	0	0

Associated (n=35)	23 (66%)	12 (34%)	9%	100%	100%	100%	100%	2.2	10 (29%)	25 (71%)	19 (54%)	8 (22%)	4 (12%)	4 (12%)
Total (n=84)	26 (31%)	58 (69%)	4%	100%	100%	100%	100%	2	10 (12%)	74 (88%)	67 (80%)	8 (10%)	5 (6%)	4 (4%)
Polydactyly														
	Indications for US		Prenatal Detection				Gestational Age at Dx		Pregnancy Outcome					
	High Risk	Other	Sensitivity	Specificity	PPV	NPV	<22 wks	>22 wks	LB	TOP	STB	NND		
	21 (8%)	229 (92%)	18%	100%	98%	100%	-	-	240 (95.5%)	7 (3%)	2 (1%)	1 (0.5%)		
	50 (63%)	30 (37%)	24%	100%	82%	100%	-	-	42 (52%)	23 (29%)	2 (3%)	13 (16%)		
	71 (22%)	259 (78%)	19%	100%	93%	100%	54 (16%)	276 (84%)	282 (86%)	30 (9%)	4 (1%)	14 (4%)		
Total (n=330)														

PPV, Positive Predictive Value; NPV, Negative Predictive Value; LB, Live Birth; TOP, Termination of Pregnancy; STB, Stillbirth; NND, Neonatal Death