بسم الله الرحمن الرحيم

Sudan University of Sciences and Technology

College of Graduate Studies

Study of Developmental Hip Dysplasia in Saudi Infants Using Ultrasonography

دراسة الخلع الوركى لدي الأطفال السعوديين باستخدام التصوير بالموجات فوق الصوتية

A thesis Submitted for Partial Fulfillment of PhD in Medical Diagnostic Ultrasound

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DeDica t ion

To my husband and my children whom tolerated and gave me more patinence and understanding during my work on this research.

Allah bless them

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ABSTRACT

The objectives of this study were to characterize the DDH in Saudi infants using US, also to evaluate the hip joint for infants who were clinically diagnosed to have Developmental hip dysplasia (DDH) focusing mostly on the Graf's method using ultrasonography, by measuring the α and β angles and correlate the results with the anatomical findings related the hip. The study was conducted during the period extended from 2011 up to 2017. The hips of 536 newborn infants were examined by US using routines screening program for DDH at age 1 day up to 4 months. Ultrasonographic examination was performed with a 12-7.5,3.5, 5 MHZ, linear transducer (Toshiba, Philips 2010, volusum4000, Son layer SSA-270A, Japan). The sample including 145 (27.1%) females and 391(72.9%) males. Participant's age were <30 days were 506(94.4%),31-60 days were 9(1.7%),61-90 days were 11(2.1%) ,and ages between 91-120 days were 10(1.9%). The most common affected age were ages<30 days, 280 were of type1, 9 were 2a < 3m, 75 were 2b >3m and 29 were 2c. 44 were type 3 and 30 were type 4 with significant relation with age at p<0.018, 0.000, 0.005 for type 1, 2, and 4 respectively .There is significant relation between type 2 and 3 dislocation and the risk factor. When characterizing hip joint and its development in different types of DDH, results showed that the acetabulum is well developed in type 1 and least developed in type 3 and 4 significantly at p <0.002, 0.000,0.000 the femoral head is outside the acetabuler cavity in both type 3 and 4 while it was found inside the groove in type 1 .The ischium was found to be well developed in type1 while in type 3and4 most of the cases were not developed .Normal Illiac line capsule, acetabular cartilage, Femoral head ligament were detected in type 1 where significant changes were detected in type 3 and 4. Results revealed that there was significant association between the β angle and acetabulum development,

normality of the acetabuler labrum and normal presence of femoral head within the acetabuler cavity, at $p < 0.000, 0.000, 0.000$ however the α angle should be considered if there is abnormal presentation of the labrum . Ischia development and acetabular bony roof rim , joint capsule , acetabular hyaline cartilage and femoral head ligament normality were well correlated with the β angle at $p < 0.006$ and 0.000 this revealed that it was better to measure the α and β angle than to define the hip morphology and pathology alone .

المستخلص

كان الهدف من هذه الدراسة هو توصيف خلل التنسج المرتبط بالنمو لدي الاطفال السعوديين, باستخدام التصوير بالموجات فوق الصوتية، بالاضافة الي تقييم مفصل الفخذ بالنسبة للمواليد الذين تم تشخيص حالاتهم بانها خلل في التنسج المرتبط بالنمو، بالتركيز بصورة اساسية علي طريقة (قراف) في التصوير وهي تتعلق بقياس زوايتي الفا و بيتا, وتم مقارنه النتائج مع النتائج التشريحية ذات الصله بالفخذ. تم اجراء الدراسة في الفترة من عام 2011 الي 2014، واشتملت على افخاذ 536 طفل حديث الولادة تم تصويرهم بالموجات فوق الصوتية باستخدام البرنامج الكشفي المعتاد، وترواحت اعمار المواليد بين يوم واربعة شهور. تم التصوير باستخدام 12-7.5,5,3.5,5 ميقاهيرتز، بواسطة البرجام الخطي وماكينات (توشيبا، فيلبس 2010 ، فولوسم 4000 ، SSA-A270 سون لير اليابانية). كان عدد الاطفال الذين تقل اعمارهم عن 30 يوم 506 (94.4%) والذين تترواح اعمارهم بين 60-31 يوما 9 (% 1.7) والذين اعمارهم بين 61-90 يوما 11 (2.1%) والذين اعمارهم 120-91 يوما 10 (1.9%). وكانت اكثر الاعمار تاثرا هي الاعمار اقل من 30 يوما حيث 280 من النوع ()1 ، 9 من نوع 2 a < 3m ، 75 من نوع 2 b > 3m ،و 29 من نوع 2 C ، 44 من نوع (3) ، 30 نوع (4) مع وجود علاقة ذات دلالة احصائية بالنسبة للعمر عند P= 0.018,0.000,0.005 بالنسبة للانواع 1،2،4 علي التوالي. وهنالك علاقة مهمة بين النوعين 2 ، 3 فيما يتعلق بخلع المفصل وعامل الخطورة. عند توصيف مفصل الفخذ ونموه في الحالات المختلفة لخلل التنسج، اوضحت النتائج ان عظمة الحق نمت بشكل جيد في النوع (1) وبشكل اسوا في النوعين (3) و (4) وكانت موجودة داخل التجويف في النوع (1)، مع وجود اهمية احصائية P< 0..000,0.019,0.000 وقد وجد راس عظم الفخذ خارج تجويف الحق في النوعين (3) و (4). كشفت النتائج وجود ارتباط قوي بين زواية بيتا ونمو عظمة الحق وسلامة حافة الحق والوجود الطبيعي لراس عظمة الفخذ داخل تجويف الحق، عند: p<0.000,0.000,0.000 . ويوجد اعتبار خاص بزاوية الفا اذا كان هناك بروز غير طبيعي في حافة الحق . اما بالنسبة لتطور الورك والسقف العظمي للحق وحافة الحق العظمية وكبسولة المفصل وغضروف الحق و رباط راس عظم الفخذ فان سلامتها جميعا مرتبطة مع زوايه بيتا عند: p<0.006,0.000,0.00. وكشفت الدراسة انه من الافضل قياس زوايتي الفا وبيتا من محاولة تحديد تركيب عظمة الفخذ وامراضها فقط. وهذا يكشف أن قياس زاويتي ألفا ويتا افضل من تحديد التكوين النسيجي للفخذ وتحديد المرض فقط.

LIST OF ABBREVIATIONS

&	Alpha angle
A C	Acetabulum
AC	Ace tabular cartilage
B	Beta angle
B	Base line
C	Cartilage
CHD	Congenital hip dislocation
DDH	Developmental dysplasia of hip joint
FH	Femoral head
G	Gluteus muscle
H	Head
IL	Ilium
IL	Ilium
IS	Ischium
L	Labrum
L	Left angle
L	Labrum
R	Right angle
TR	Triradiate cartilage

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CHAPTER ONE

Introduction

Chapter one

INTRODUCTION

1.1 Introduction

Estimates of the incidence of developmental hip dysplasia (DDH) I infants vary between 1.5 and 20 per 1000 births. (Patel H et al 2001)The incidence of DDH in infants is influenced by a number of factors, including diagnostic criteria, gender, genetic and racial factors, and age of the population in question.(American Academy of Pediatrics 2000) The reported incidence has increased significantly since the advent of clinical and sonographic screening, suggesting possible overdiagnosis.(Bialik V et al.1999) In addition to a higher prevalence of DDH in females, reported risk factors for the development of DDH include a family history of DDH, breech intrauterine positioning, and additional in utero postural deformities.(Omeroglu H et al 2001, Yiv BC et al 1997, Chan A et al 1997). However, the majority of cases of DDH have no identifiable risk factors (Archives of Disease in Childhood. 1986)

The infantile hip ultrasonography method of Graf is the most widely used method. If the previously well-defined examination, interpretation and measurement techniques are meticulously followed, it is easy to manage the newborn hip problem by using this method .(Graf R (2006)) In older children, a large femoral head ossification centre can obscure the visualization of the lower limb, which is essential for obtaining a standard plane, so this method is ultimately limited by the age of the patient [Graf R (2006)].However, the Graf method may be used in older children if the visualization problem of the lower limb can be overcome (Ozc¸elik A et al 2005)

According to the Graf ultrasonographic hip classification system, the a and b angles are the quantitative indicators of the bony and cartilage acetabular roofs, respectively. The a angle mainly determines the hip type and the other parameters, such as the age of the patient, b angle value, b angle value under stress, course of the perichondrium of the cartilage acetabular roof and structural changes in the cartilage roof, give particular differentiations (Graf R (2006)) . A hip joint becomes ultrasonographically mature at 34 weeks of gestation (Stiegler H et al 2003) If an initially mature (type I) hip deteriorates over time, it is due to a neuromuscular hip instability, a hip joint effusion or a secondary hip dysplasia following a successful treatment. Otherwise, the initial diagnosis is wrong (Graf R (2006), Graf R (2007)). Graf advocates the immediate treatment of type IIa- and worse hips (Graf R (2006)) However, there still exists controversy in the natural history and management of immature hips. Graf type IIa hips has a lower spontaneous normalization rate and a higher treatment rate in girls than in boys (Omerog˘lu H et al 2013). Graf recommends to treat the type IIa- hips for completely avoiding the development of residual hip dysplasia and to closely follow the type IIa hips for determining whether or not a mature hip can be attained by the end of 3 months (Graf R (2006), Graf R (2007) Besides, nearly one in every four type IIb hips carries the risk of development of residual hip dysplasia in the long-term follow-up, even if they have initially been treated with success (Sibin´ski M et al 2012)

This research documents the results of a prospective study designed to determine the validity of a standardized ultrasound and clinical screening protocol for early detection of developmental dysplasia of the hip in Saudi infants during their first 6 months;as well to characterize the hip joint anatomical structure in different types of DDH.

Developmental dysplasia of the hip (DDH) is a term explaining the situation in which the femoral head has an abnormal relationship to the acetabulum. DDH includes luxation, subluxation, instability wherein the femoral head is not localized inside the socket reflecting the inadequate formation of the acetabulum. Most of these findings may not be there at birth, and the earlier a dislocated hip is acknowledged, the more successful is the management. Despite newborn screening programs, dislocated hips continue to be diagnosed later,(Bjerkreim I et al 1993, Dezateux C et al 1995, Krikler S et al 1992, Macnicol M et al 1990, Marks DS et al 1994, Rosendahl K et al 1992, Sanfridson J et al 1991, Yngve D et al 1990)

Due to the hip profound anatomical location, the physical examination becomes difficult; as well the hip joint effusions cannot be easily detected by clinical examination (Iagnocco A et al 2006, Bianchi S et al 2007, Qvistgaard E et al 2006, Atchia I et al 2007). Therefore imaging tools are necessary .Over the last decade; well as a dynamic real-time study of multiple planes (McNally EG 2005, Naredo E 2007, O' Neill J 2008, Schmidt WA et al 2004, Martino F et al 2006, Cho KH et al 2000, Bonilla G et al 2005, Valley VT et al 2001, Blankenbaker DG et al 2006, Fearon AM et al 2010, Choi YS et al 2002, Micu MC et al 2010, Sofka CM et al 2005, Migliore A et al 2005, Migliore A et al 2006).

Many infantile hip ultrasonography methods Ultrasonography (US) has proven to be a useful tool in the assessment of musculoskeletal anatomical structures. US has great role in the detection and differentiation between intraarticular and extraarticular pathology, as well US has good visualization of the joint cavity, quantification of soft tissue abnormalities, as were used to evaluate the DDH including Graf, Harcke, Terjesen and Suzuki methods. (Hakan O et al 2014).

Plain radiography was the gold standard for the radiological diagnosis of (DDH) However, exposure to radiation and difficulties in studying the relationship between the cartilage femoral head and bony acetabular roofs lead to substandard its value during early infancy in DDH. On the other hand US can detect the hip problems that can be missed by clinical and radiographic examinations. (Wientroub S et al 2000, Harcke HT 2005).

The questions to be answered: can ultrasound has ability to detect DDH?, and to how much degree we can significantly depend upon the infantile hip ultrasonography methods in the diagnoses. Therefore the aim of the current study was to evaluate the hip joint for infants who were clinically diagnosed to have DDH focusing mostly on the Graf's method using ultrasonography, by measuring the α and β angles and correlate the results with the anatomical findings related the hip .

1.2 Study problem

This high radiation dose with conventional x-ray in the diagnosis of developmental of the hips. Nowadays ultrasound is widely used for diagnosis of many diseases especially of Musculoskeltal. Can ultrasound replace the conventional x-ray in the infants? And what are the characterize of developmental dysplasia of hip joint (DDH) in Saudi infants.

1.3 Objectives

1.3.1 General Objective:

To study developmental hip dysplasia (DDH) using ultrasound in Saudi Arabia.

1.3.2 Specific Objectives:

- To evaluate the angular measurement alpha and beta(α .β) by Graf methods
- To characterize anatomical structures in each types of dislocation.
- To evaluate common types of DDH in Saudi infants
- To characterize the types of dislocation according to clinical data and risk factors.

1.4 Overview of the Study:

The study was calcified in five chapters.

Chapter one: dealt with introduction of the study in which the general objective specific objectives, study problem and ethics issue.

Chapter tow: dealt with theoretical background and literature review

Chapter three: dealt with materials and methods

Chapter four: dealt with result

Chapter five: dealt with discussion, conclusion, recommendations, reference and appendix

Chapter Two

Literature Review

Chapter Two

LITERATURE REVIEW

Definition of Developmental Dysplasia of the hip or DDH:

Is generally the preferred term for babies and children with hip dysplasia since this condition can develop after birth. DDH is the medical term for general instability, or looseness, of the hip joint .used to describe problem with formation of the hip joint in children. The location of the problem can be either the ball of the hip joint (femoral head), the socket of the hip joint (the acetabulum), or both. More recently, the accepted terminology is developmental dysplasia of the hip, or DDH. (Marks DS, et al 1994)

These names include: Hip Dysplasia, Developmental Dislocation of the Hip (DDH), Developmental Dysplasia of the Hip (DDH), Ace tabular Dysplasia, Congenital dislocation of the hip (CDH), Hip Dislocation. (Naredo E. et al 2007)

2. 1 Anatomy of the hip joint

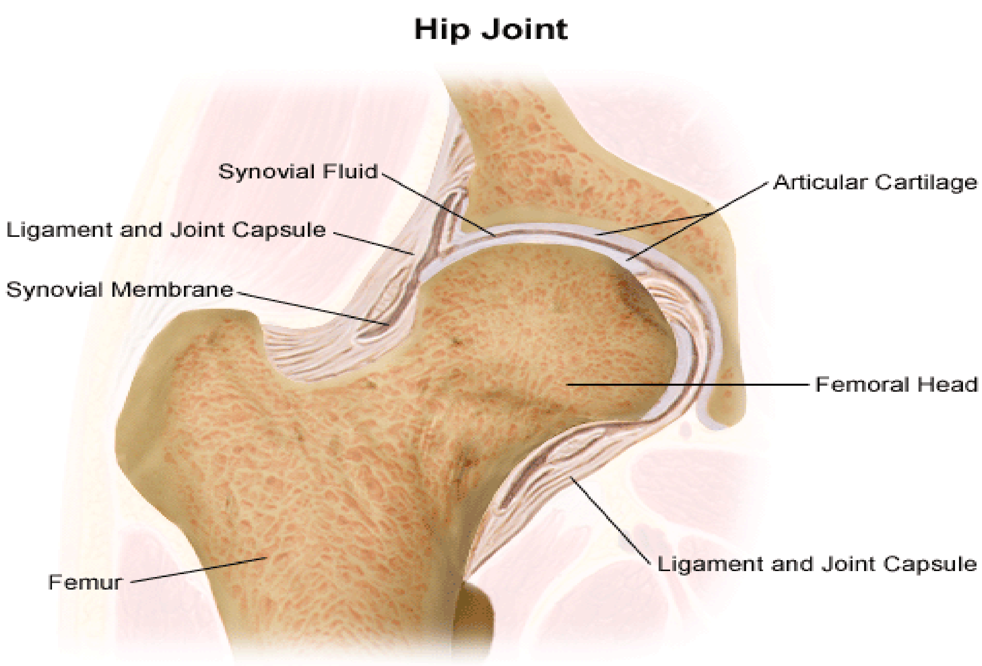


Figure 2.1 shows the anatomy of the hip joint
https://ww.bjj.bone and joint org.uk

2.1.1 Contains of Hip Joint:

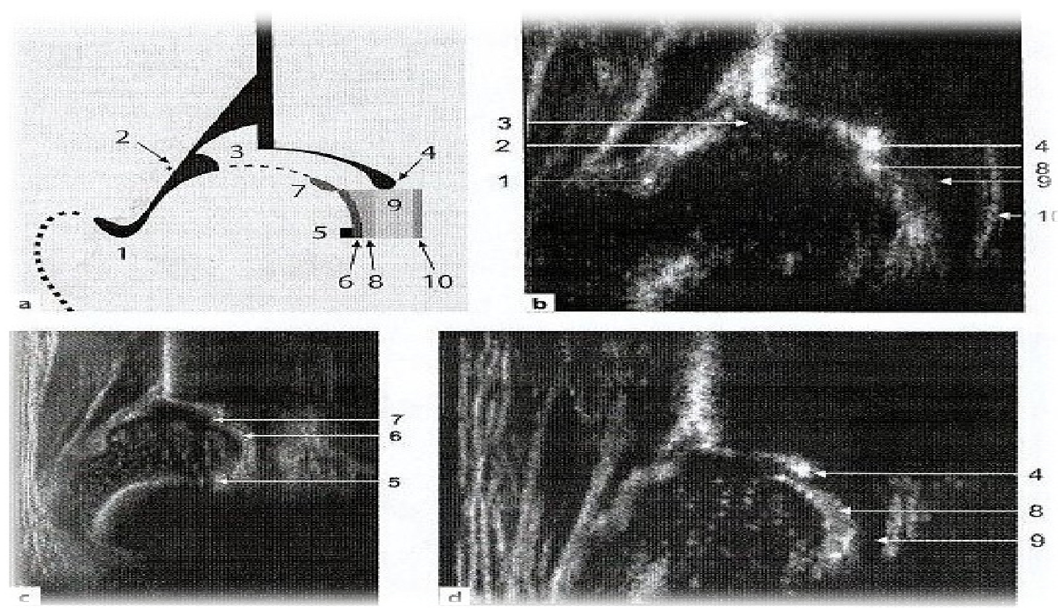
Femur, cartilaginous, Femoral Head, Synovial Fold, ligament and Joint Capsule, Ace tabular Labrum, Hyaline Cartilage, Bony part of ace tabular roof, Ilium.

The ball is called the femoral head is the top of the femur or thigh bone.

The socket is called the acetabulum and is the apart of the pelvis.

The femoral head fits into the acetabulum creating the hip joint.

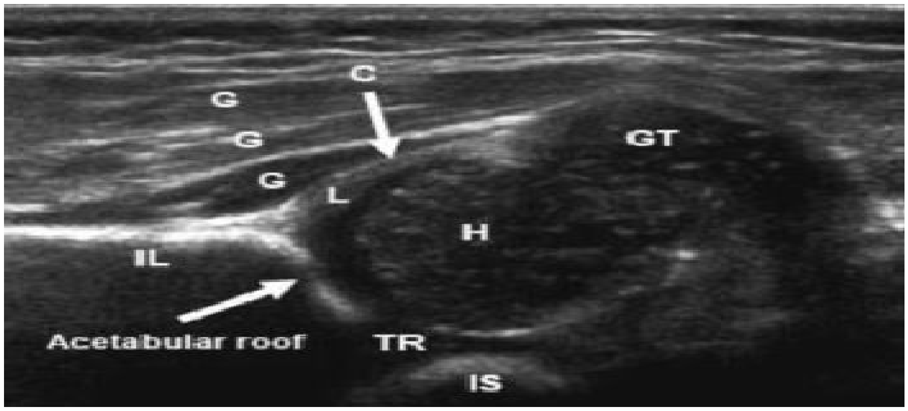
The joint is normally held tightly in placed by the surrounding ligaments. (O Neill. et al New York 2010)



1

Figure (2.2) Illustrated the ultrasound anatomy of hip joint

Show identifying anatomical structures of the hip joint : **1**ilium synovial fold;**2** labrum;**3** irradiate cartilage **4**, **5**, transverse ligament **6**, ligament teres **7** Infant acetabulum fovea centralis ;**8**, fatty tissue in the ace tabular fosse: cartilaginous ace tabular roof, **9** triradiate cartilage;**10** (Graf 2006)



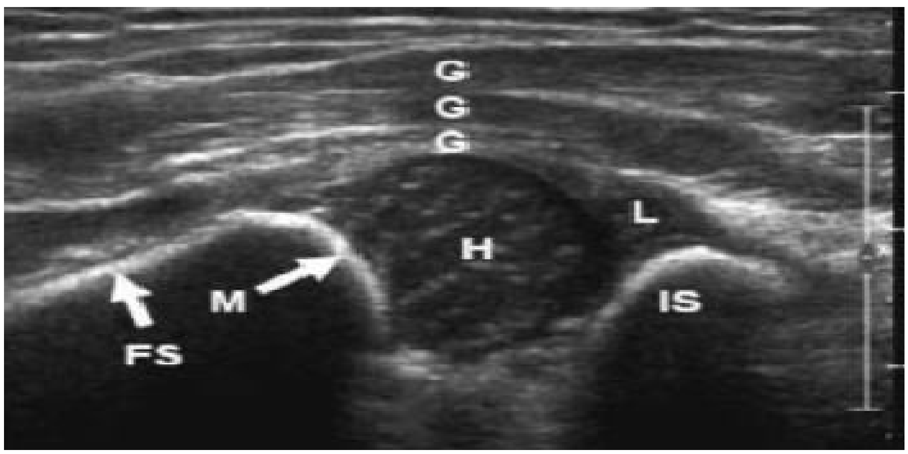


Figure (2.3) coronal, transverse view shows the ultrasound anatomy of hip joint

(Martino F, et al 2010)

G. greater trochanter, **H** head , L labrum **IS** ischium **FS**. femoral shaft ,

M .metaphsis

2.1.1.1 Femoral head:

The femoral head is not completely rounded but is slightly oval or nut or oval joint with consequent physiological incongruities causing the phenomenon of elastic whipping or normal movement of the cartilaginous ace tabular roof when the head rotates in the acetabulum.

At birth the femora l head, greater trochanter and, hat – shape, proximal portion of the femoral neck are of hyaline cartilage. These are separated from the bone shaft by the Chondro- Osseous border (epiphysis plate).(Graf R2007)

Songraphic Features: Is hypo echoic or anechoic (depending on machine settings).

2.1.1.2 Hyaline cartilage is found in:

The femoral head, proximal femoral neck and greater trochanter of the femur, the cartilaginous portion of the ace tabular roof, the irradiate cartilage. (Graf R. 2007)

Songraphic Features: Being hyaline cartilage, the femoral head is hypo echoic or echoic .The small echoes of the sinusoids in the hyaline cartilage may be seen.

2.1.1.3 Synovial Fold and Joint Capsule:

The lateral side of the femora l head is covered by the joint capsule. This is closely applied to the femoral neck and is continuous with the perichondrium of greater trochanter . The point at which the capsule is reflected off the neck to become the perichondrium is referred to as the synovial fold.(Graf R. et al 2005).

The synovial fold is a poorly defined bright echo, or two close parallel line echoes. The labrum is the hypo echoic hyaline cartilage portion of the ace tabular roof, medial to which are the bright echoes of the bony acetabulum.

The inner- most portion of the bony acetabulum is the lower limb of the iliac bone. hypo echoic triradiate cartilage .On the lateral surface of the triradiate cartilage is hypo echoic fatty tissue in the ace tabular fosse. between the fatty and femoral head the bright echoes of the Liqamentium terse may be seen. This insertion gives a strong echo.

(Graf 2010)

Figure (2.4) 1- Lower limb of ox Ilium 2- joint capsule 3- cartilaginous part of the ace tabular roof 4- labrum

Identifying the anatomical structures of the condors –osseous ace tabular:

1- Labrum

2- Lower limb of ox Ilium

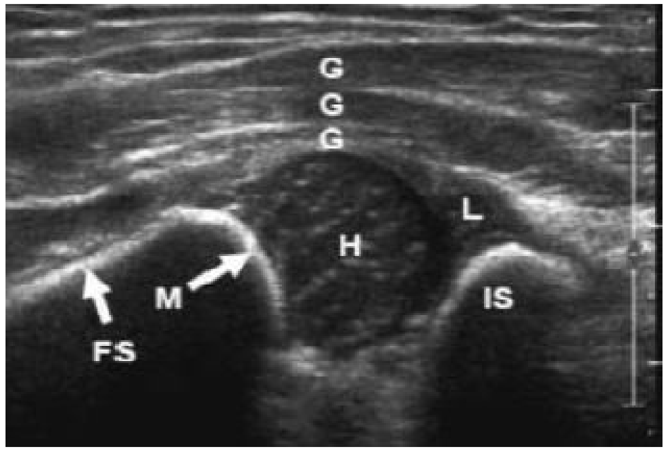
3- Cartilaginous part of the ace tabular roof. (Graf 2006)

Son graphic Features: The synovial fold is a poorly defined bright echo, or two close parallel line echoes. The labrum is the hypo echoic hyaline cartilage portion of the ace tabular roof, medial to which are the bright echoes of the bony acetabulum. The inner- most portion of the bony acetabulum is the lower limb of the iliac bone. hypo echoic triradiate cartilage .On the lateral surface of the triradiate cartilage is hypo echoic fatty tissue in the ace tabular fosse. between the fatty and femoral head the bright echoes of the Ligmentium terse may be seen. This insertion gives a strong echo.(Graf R. 2007).

2.1.1.4 The Ace tabular hyaline cartilage and ace tabular roof and Ace tabular Labrum:

Ace tabular consists of a bony and cartilaginous portion. The cartilaginous portion is composed of the hyaline cartilage of the ace tabular roof and the fibro cartilaginous ace tabular labrum. The labrum is the most peripheral part of the ace tabular. The inner- most portion of the bony acetabulum is the lower limb of the iliac bone .(Graf R,etal2005).

Songraphic features: the fibrocarttilaginous labrum is highly echogenic, whereas the hyaline cartilage of the ace tabular roof shows few echoes.



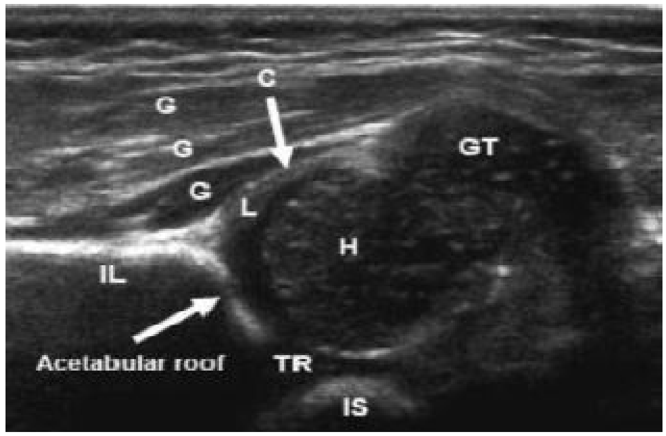
(Martino F, et al 2007)

Figure (2.5): show L: labrum, H: femoral head with hyaline cartilage, M: acetabulum morphology, FS: femoral shaft, IS: irradiate cartilage

2.1.1.5 The lower limb of the ox Ilium:

The lower limb of the ox Ilium measures 1- 3 mm in size depending on the age of the baby. The lower limb must be clearly identified. It is an essential marker of the correct sectional plane and must be clearly seen on the ultrasound unless the hip is decent red.

Son graphic Features: The Ilium must be horizontal, sharp, centrally located. highly echogenic structures. The lower limb of the ox Ilium is approximately half way between the anterior and posterior rims of the ace tabular and casts an acoustic shadow. (GRAF R (2007) the use of ultrasonography



(Martino F, et al 2008)

Figure (2.6): show IL: ilium, GT: greter trochanter, TR: triradiate cartilage, IS: ischium, GT: greter trochanter

2.1.1.6 Fat and Fibrous Connective Tissue

There is pad of fat and connective tissue on the floor of the ace tabular fosse.

Son graphic features: Which may be seen as weak echoes overlying the lower limb of the ox Ilium._Usually give few or weak echoes, sometimes fat may be anechoic. In the infant hip fatty tissue may be seen as hypo echoic zone in the ace tabular fosse between the lower limb of the us Ilium and the ligament terse or between the insertion of the joint capsule and the reflex head of the rectus –femora is muscle. (Keller et al 1988)

2.1.1.7 Ligaments:

Femoral head ligament, Ligament Trees (the ligament of the femoral head)

Son graphic features: Its strong reflection (echo) from its insertion into the femoral head at the central fovea to its insertion into the lower ace tabular margin. The strong echo must not be confused with the Ilium.(Dias et al 1993)

Femoral head Blood Supply

1. Liqamentium terses artery
2. Physis (Growth plate)
3. Medial circumflex artery
4. Lateral circumflex artery
5. Profound femora's artery

2.2 Physiology of the hip joint:

Functionally, the hip joint a very high motion. The ball and socket structure of the joint allows the femur to circumduct freely through a 36 degree circles. The femur may also rotate around its axis about 90 degree of the hip joint. Its primary functions is to make the legs mobile without weaking the ability to the support the weight of human body in both static and dynamic postures hip joint are most important factors in maintaining balance of body.(BAR-ON et al , 1998, jomha et al 1995)

2.3 Pathological changes in infants

There are two forms of hip dislocation.

2.3.1 Teratology Dislocation:

The hip joint fails to form properly during embryological development. The femoral head and socket show severe deformormities and the femoral head were never in the correct position [teratology form]. The cell configuration for the labrum, bony roof and hyaline cartilage were never normal.(Harkan O - et al 2014)

2.3.2 Developing Dislocation:

Initially the femoral head was positioned in the socket but certain biomechanical factors cause the normal development to cease and the femoral head begins to slide out of the socket deforming the acetabulum (developing dislocation of the hip –DDH).

If the femoral head slides out of the socket, this process of dislocation leads to deformity. This is primarily of the cartilage part of the ace tabular roof but, inevitably, the bony portion becomes damaged also. The femoral head leaves grinding marks on the ace tabular roof during the process of dislocation. Through accurate analysis of the pathological changes in the cartilage and bony socket it is possible to state the severity of the pathology affecting the hip joint.(Harkan o.et al 2014)

2.3.3 Sign and symptoms of developmental dysplasia of the hip joints

2.3.3.1 Asymmetry: Asymmetrical buttock creases can suggest hip dysplasia in infant s but, like hip click, an ultrasound will need to be done to determine wither the hips are normal or not.(Rosendahl et al 1995)

2.3.3.2 Hip Click: Hip clicks or pops can be sometimes suggest hip dysplasia but a snapping sound can occur in normal hips from developing ligaments and around the hip joint.

2.3.3.3 Limited Range of Motion: Parent may have difficulty diapering because the hips can't fully spread.

2.3.3.4 Pain: Pain is normally not present in infants and young children with hip dysplasia during adolescence or as young adults.

2.3.3.5 Sway back: A painless but exaggerated waddling limp or leg length discrepancy are the most common findings after learning to walk. If both hips are dislocated, then limping with marked sway back may become noticeable after the child starts walking.

Other physical signs for late dislocation include asymmetry of the gluteal thigh or labral skin folds, discrepancy in leg length , a widened perineum on the affected side , buttock flattening , and asymmetrical thigh skin folds , decreased abduction on the affected side , and standing or walking with external rotation of the affected leg.(Har cke HT 2005)

2.3.3.4 Risk factors of Developmental Dysplasia of the Hip (DDH)

Risk factors for the development of DDH include a family history of DDH, breech intrauterine positioning, and additional in utero postural deformities Girls, First – born children and Babies born in the breech position (especially with feet up by the shoulders.(Omeroglu H et al 2001, Yiv BC et al 1997, Chan A et al 1997).

2.3.3.5 Radiological Investigations (DDH):

2.3.3.5.1 Physical exam: Diagnosis of hip dysplasia in the infant is based on the physical examination findings.

Both the Barlow and Ortolani test detect an unstable hip but do not detect a dislocated, irreducible hip, which is best detected by identifying limited abduction of the flexed hip) or stable hip with abnormal anatomy –e.g., ace tabular dysplasia. The pediatrician will feel for a 'hip click' when performing special maneuvers of the hip joint. These maneuvers, called the Barlow and Ortolani test, will cause ahip that is out of position to 'click' as it moves in and out of the proper position. If a hip click is felt, they will usually obtain a hip ultrasound to assess the hip joint. (Rosendahl et al 1995)

2.3.3.5.2 conventional x-ray:

does not show the bones in a young baby until at least 6 months of age, hip tissue has not yet hardened from flexible cartilage (which won't not show up on (x – ray) to bone . (peterdincd, et al 2010)

2.3.3.5.3 Ultrasound:

The hip ultrasound will show the position and shape of the hip joint. Instead of the normal ball- in socket joint, the ball outside the socket, and a poorly formed (shallow) socket.

The hip ultrasound can also be used to determine how well the treat ment is working. (K. Rosendahl et al 1992)

2.3.3.6 Types:

The ultrasound typing correlates with the pathos-logical changes in the hip joint rather than with the height of the dislocated femoral head .the height of the dislocated femoral head does not automatically correlate with the severity of the anatomical deformity .

The hip is then classified into one of four main types according to graphs classification (Bache et al 2005).

(Table 2.1). **Ultrasound classification of DDH (type1,11,111,IV)**

Sonogrphic Anatomic Classification of infant Hip Dysplasia (Rosendahl K et al 1994)

Type	Alpha angle	Beta angle	Comment
1	>60	-	Normal
11A	50 -59	-	Physiological immaturity(<3monthold)
11B	50-59	-	Delayed ossification(>3months old)
11C	43-49	<77	Critical zone :labrum not averted
11D	43-49	>77	Subluxes :labrum averted
111	<43	>77	Dislocated
1V	<43or not	>77	Dislocated with labrum interposed
	Measurable		Between femoral head and acetabulum

This classification is based on the degree of femoral head displacement and the associated deformation and growth retardation of the ace tabular roof. Type I indicates a normal hip with a good cartilaginous and osseous roof (an angle of 60 degrees or more). Type II a represents an immature hip in an infant who is younger than three months of age , with delayed ossification but an adequate cartilaginous roof and an angle of 50to 59 degrees. Type II b refers to a hip with delayed ossification in an infant more than three months of age, with a rounded , osseous ace tabular promontory ; an angle of 50 to 59 degrees ; and a b angle of more than 55 degrees .Types II c, D,III, and 1V are always pathological . In types D,III, and IV, the bone- molding of the acetabulum is severely deficient or poor and there is lateralization of the femoral head. The angle is 43 to 49 degrees in types 11c and D and less than 43 degrees in types III and IV. The b angle is 70 to 77 degrees in type II c and more than 77 degrees in type II c and more than 77 degrees in types D,III, and IV. The cartilaginous acetabulum is displaced superiorly and is ultrasonogrphically dense in type IIIb. (Rosendahl K et al 2003, Ganz R et al 2003)

Table (2. 2): Ultrasonographic Hip Types (Graf 2007)

Hip Type	Osseous Roof Contour	Superior Osseous Rim	Cartilaginous Rim	Osseous Roof: a Angle *(degrees)*	Cartilaginous Roof: b Angle *(degrees)*
Fully mature (any age)					
Ia	Good	Angular	Narrow; triangular; covers femoral head	60	<55
Ib	Good	Usually slightly rounded (blunt)	Wide-based; short; covers femoral head	60	>55
IIa+: physiological delay of ossification appropriate for age (before age of 3 mos.)	Adequa te	Round	Wide; covers femoral head	50-59	>55
IIa-: physiological delay of ossification with maturity deficit (before age of 3 mos.)	Deficie nt	Round	Wide; covers femoral head	50-59	
IIb: delay of ossification after age of 3 mos.	Deficie nt	Round	Wide; covers femoral head	50-59	>55
IIc: critical range (any age)		Round to flat	Wide; still covers femoral head	43-49 (critical range)	70-77
D: decentering (any age)	Severel y deficie nt	Round to flat	Displaced	43-49 (critical range)	>77 (decentering range)
Eccentric					
IIIa	Poor	Flat	Displaced, without structural alteration	<43	>77
IIIb	Poor	Flat	Displaced, with structural alteration	<43	>77
IV	Poor	Flat	Displaced inferomedially	<43	>77

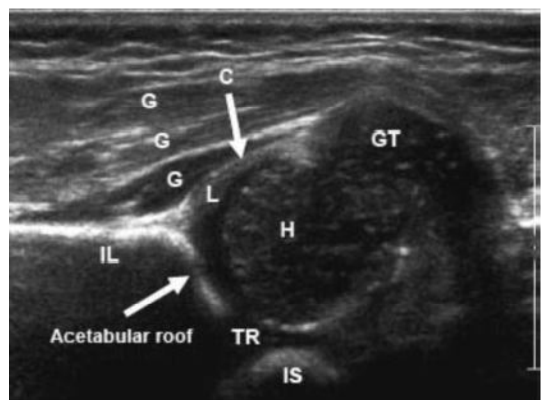
2.4 Ultrasound technique and measurement technique in infant hip joint:

2.4.1 Hip preparation

There's no preparation during hip examination, Before start examination of the baby the nursery nurse or mothers gives breast feeding or bottle to make the baby cool without crying because the movement of the baby's will give errors of diagnosis . (Harcke HT 2005)

2.4.2 Scanning technique

- Static (Graf method) assessment in coronal plane with hip at rest, based on shape and depth of acetabulum by morphology and angular measurement.Coronal view the ultrasound transducer is placed parallel to the lateral aspect of the infant’s hip

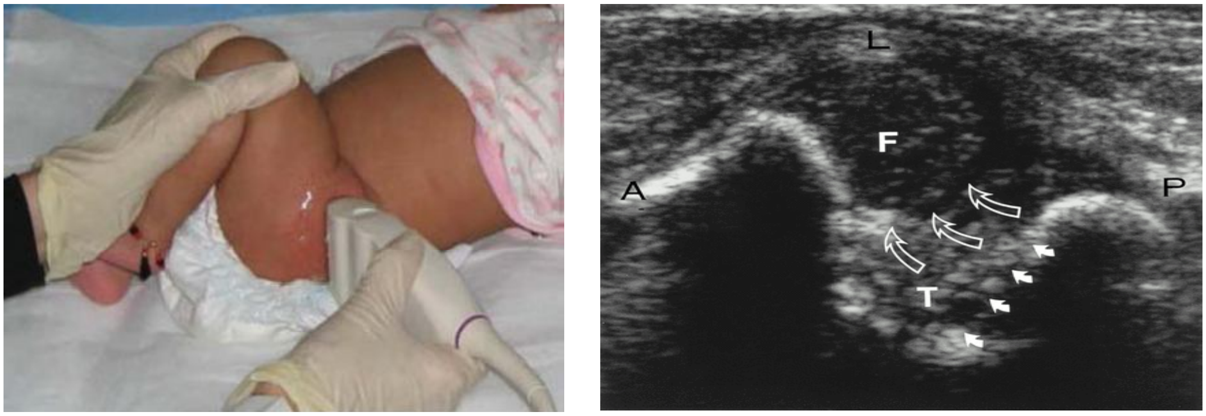


A **B**

Figure (2.7) A, B show Coronal ultrasound image.

(Harcke HT 2005)

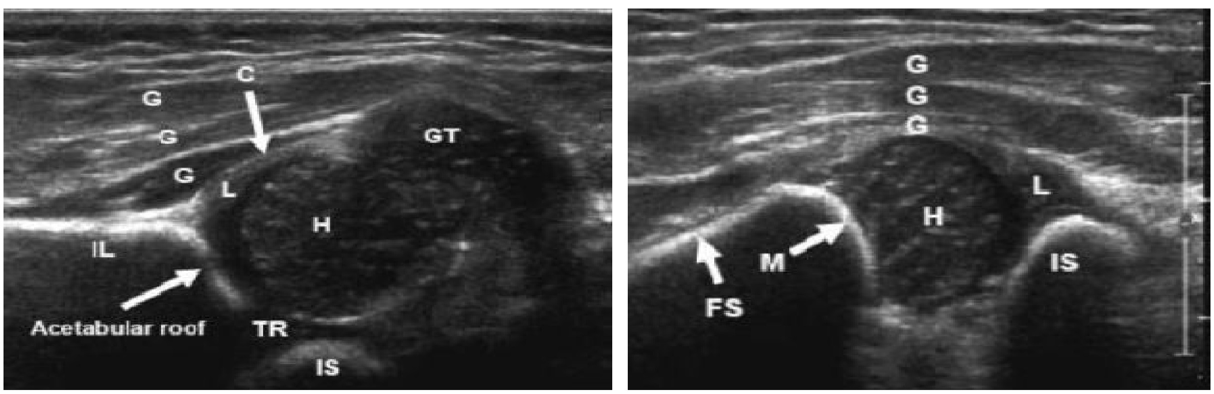
Capsule; G, gluteus muscles; H, cartilaginous **,** femoral head; IL, ilium; IS, ischium; TR, triradiate cartilage; GT, greater trochanter; and L labrum.



Harcke HT (2009) imaging methods used for children

Figure (2.8) show transverses ultrasound image.

A transverse flexion ultrasonographic view of a normal hip shows the femoral head (F) A = anterior, L = lateral, and P = posterior. Fibrofatty tissue (T)



(A) **(B)**

Figure (2.9) (A.B) shows coronal and transverses ultrasound image.

GT: Greater trochnter, TR: Triradiate cartilage, IS: Ischium IL: L Harcke HT (2009)

2.4.3 Complication of DDH – if Untreated

Pain, Early osteoarthritis, Limb length discrepancy, Decreased agility, Abnormal gait/ limping

2.5 Previous study

They reported our experience with 131 examinations in 104 patients, comprising 259 single hip studies. Of 83 patients who were previously untreated, there were 178 hip studies with three false-negative and four false-positive ultrasound results. No dislocations were missed. Twenty-seven patients who were already being treated were examined to assess hip location, comprising a total of 81 hip studies. In some cases the patients were examined while in an abduction device, cast, or Pavlik harness. In one case a dislocation was not detected. The method of examination using real-time ultrasound is considered to be reliable, accurate, and a useful adjunct to radiography. The advantages are that it is non-invasive, portable, and involves no exposure to radiation. (P M Dunn R E Evans et al 1985).

(Bjerkreim 1974, Morrissey and cowrie 1987) mentioned in the previous study the rotini test and other test of clinical instability are completely reliable , since false positive aswell as false negative results occurs even in the hands of experience d examiners. Consequently, new screening method s is desirable. Ultrasound has been established as value bletechniques for evaluating the hips infants (Kettles and Desman 1985: Zinger, Schulz and Wiese 1986; Benze-Bohm et al 1987; Wetzel 1987.

In other study(Neither and Roesler 1987) reported the most widely used method of evaluating ultra-sonogram in the newborn is to measures the bony roof angle (alpha angle) and the cartilage roof angle (Beta angle) by Graf method1984. However, various authors have found this method unreliable in the new born, since errors of+_ 10 are possible. They found this method have ability to differentiating normal from abnormal hip and extended to our method to detect hip pathology which is not clinically demonstrable.

The Hip of 1000 new born babies was examined clinically and by ultrasonography. The ultrasound assessment was based on measurements of the coverage of the femoral head by the bonyace tabular roof , and this parameters was called the bony rim percentage(BRP), The mean BRP was 55.3% in girls and57.2%in boys. Clinical instability accrued in 0.7% of the new born babies, and of the unstable hip had PRF below the lower limit of normal. ALL infants with normal clinical finding and suspected abnormal hip based on ultrasound have followed up: in all but two the hip become normal spontaneously. (TERJESEN, et al 1989).

Another study mentioned in Malaysian Neonates prospective study was carried out in the Maternity Hospital, Kuala Lumpur over a 2-year period. During this time, 52,379 deliveries took place. 36 neonates (0."7 per 1000 births) were found to have congenital dislocation of the hips (CDH) by both the Ortolani and Barlow's manoeuvre. CDH was most common in the females (female to male ratio was 2.3: '1), the first barns (GQ% of the affected cases) and babies who had breech delivery (10.7 per 1000 births). In 21 (58.3%) of the affected neonates, CDH occurred in both hips. According to the classification of newborn infants' hips by Finlay et al, 88.9% of the neonates had unstable hips while 8.3% had pathological hips. Family history of CDH was present in 5% of the patients. 8 (22.2%) of the neonates had other associated congenital abnormalities. (NY Boo, T Rajaram 1989)

This study from Terse tejesn, tobiasbredland, from TR ondheim university hospital, Norway (K. Rosendahl, T. Markestad, R.T. Lie 1992) recent study has suggested that ultrasound examination improve diagnosis accuracy in congenial dislocation of the hip. And provide a more reliable basis for identification of infants who need treatment during early infancy. The aim of this study was to compare ultrasound mobility with ultrasound morphology and clinical stability.

Another study mentioned in Norwegian infants despite the introduction of clinical screening and early treatment of congenital dislocation of the hip (CDH), the prevalence of subluxated/ luxated hips in later infancy is still reported to be as high as 1-3 per 1,000 infants. Using ultrasound, it is possible to evaluate both hip morphology and hip stability. Hip morphology is best evaluated using Grafs coronal section through the deepest part of the acetabulum. Classification of the hips into different categories can then be based on measuring the angle of inclination of the acetabulum (alpha-angle) or femoral had coverage. Hip stability can be assessed by a Barlow-equivalent provocation test during the ultrasound examination. In the Norwegian newborn population approximately 85% of the infants have morphologically normal hips (based on the alpha-angle) while 12% have immature and 3% dysplastic hips. About 80-90% of infants with dysplastic acetabula show only minor changes, and many of the hips normailze without treatment. Severai studies indicate that universal ultrasound screening might reduce the occurrence of late diagnosed congenital dislocation of the hip.(Rosendahl K et al 1997)

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In other study done by (Falliner et al 1999) The reliability of Grafs technique in diagnosing developmental dysplasia of the hip (DDH) is investigated in this report. In a prospective study, 6,548 neonates were examined clinically and sonographically; 470 children were reexamined at least once. Sonographic a angles and radiographic acetabular index (AI) angles were followed up and compared. Results were as follows: 84.6% of the hips were mature; 14.3% were physiologically immature; 1.1% were dysplastic. Of the sonographically dysplastic hips, 63% were clinically normal. Neonatal sonographic hip status was affected by family history, breech delivery, birth weight, and gestational age. At follow- up, none of the primarily mature hips had worsened. Of the type Ha hips, 89% matured spontaneously, and 11% needed abduction. The 68 dysplastic hips had matured after a maximum of 80 days' abduction, with normal [alpha] and AI angles by the end of treatment. At 1 year, the pitch had deteriorated again in six children. Grafs sonographic technique reliably diagnoses infantile DDH. Regular orthopedic checkups are needed to detect secondary deterioration of dysplastic hips.

(Bache et al 2002) reported the relation between ultrasonography findings at birth and risk factors for developmental dysplasia of the hip have not been prospectively evaluated .since implementing a routine screening program me for all new –born babies in 1989 we have collect 48000 sets of data , including family history ,birth presentation, mode of delivery and birth weight t. of the 92 babies(three per 1000 live births)with persistent ultrasonography abnormality at 6 weeks only 20% displayed evidence of clinical instability at the original examination. Female babies without the additional risks of breech birth or positive family history were quantitatively the most significant group, accounting for 75% of cases treated. The majority of babies requiring intervention would not have been identified utilizing present criteria for selective ultrasound screening.

(Irha et al 2004) in another study reported that angle parameters proposed by Graf and linear parameters introduced by Morin are the most common currently in use for quantification and classification of ultrasonography findings in the diagnosis of developmental dysplasia of the hip. The aim of this study was to determine which of the two parameters is more suited to routine clinical use. Investigation was carried out on 100 hipsof50 infants by the same examiner who obtained two separate sonograms for each hip. Based on the results of our study, angle parameters appear to be more functional in identifying and classify ingpathology, and more adequate for screening and diagnosis.

All the babies with immature hip had normal hip in follow lip studies at 4 to 6 weeks of age. Ten (77%) out of 13 infants with dysplastic hip, had positive clinical findings. Twenty (33%) infants out of 59 infants with positive physical examination, had normal sonography. The accuracy, specificity and sensitivity of physical examination were 71.1 %, 70.6% and 76.9%, positive and negative predictive values were also 16.9% and 97.5% respectively that were similar to the other studies. Although most of dysplastic hips were recognized by primary clinical examination. but 3 cases were missed. In the presence of risk factors, further caution and follow up clinical examination might be exercised and another level of screening could be considered. (Department of neonatology, vali-E-Asr Hospital Tehrran University Of Medical Sciences, Tehrran, Iran.(2005).

(Jellicoe et al 2007) reported that many ways of detecting hip instability in the newborn infant exist, including a history of risk factors, clinical examination, and ultrasound. We investigated our practice of at risk screening using subjective, dynamic and static, ultrasound followed by radiographic evaluation at 12 months. They found that the average age at presentation was 71days, with the most common reason for referring being a clicking hip.

Early diagnosis of Developmental Dysplasia of the Hip (DDH) in newborns is essential if treatment is to be successful. Despite the Introduction of clinical screening and early treatment of DDH the prevalence of subluxated/luxated hips in later infancy is still reported. For babies at· risk, some authors suggest ultrasonography (US) combined with clinical examination.(J Poul et al 2011)

(E. Bar-on et al 2010) In the prospective study they compared clinical and ultrasonographic findings of 180 high risk neonates during two weeks of their birth in a maternity hospital which is referral for high risk pregnancies. They could perform US in 180 cases with one or more risk factors of DDH, or with positive physical examination. Among them 26(15%) had immature and 13 (7.2%) had dysplastic hips. A technique of examining the infant hip joint with real-time ultrasound is described. Since the cartilaginous femoral head is clearly imaged by ultrasound, anatomical structures and their relationships can be accurately determined. Dislocated hips are easily detected and subluxations also can be visualised.

The incidence of the hip instability due to DDH was studied in the nursery department at KAUH from November 1995 to October 1996. Eight hundred nine newborn with 1618 hips were screened both clinically and with Graf's ultrasound techniques. Babies with neuromuscular disease or those referred with other medical problems were excluded.

To study the cost-effectiveness of clinical screen with ultrasonography (USG) of hip for diagnosing developmental dysplasia of the hip (DDH) in newborns. Retrospective study (2006–14). Term newborns had (i) target scan at 6 weeks—family history of DDH or breech presentation—and (ii) early scan—abnormal clinical screen.

In all, 736 babies had USG scan. Five early scans (Graf's classification; three Type IIA, one Type IIC and one Type IIIB) and 15 target scans (Type IIA) were reported abnormal. All Type IIA DDH had subsequent 12 weeks' scans normal. Babies with Type IIIB and IIC had hip reduction surgery at 6 and 16 months of age, respectively. At cost 200 INR/scan, total 147 200 INR was incurred against two possible hip replacements prevented.

Universal clinical screen with USG of hip can aid in early diagnosis of DDH in newborns. Large population-based studies from developing countries need to look in its cost-effectiveness. (Rhodes AML Clarke NMP. et al 2014)

The incidence was found to be 10.3 % with more prevalence in female newborn (6.6%) compared to male (3.7%) using ultrasound screening. Racial status had an insignificant effect in DDH incidence (5.6% in Saudi, 4.7% in non-Saudi). The higher incidences of DDH in the first 24 hours could be related to mother's relax in hormone that fades away within a short duration (± 4 weeks). It could also be related to Graf's ultrasound type IIa- which usually normalizes spontaneously later in life. A recommendation for early detection is to carry out the screening for DDH by the age of 6- 8 weeks. (Dr. Saad Jabber 2015, king Abdulaziz University Hospital - Saudi Arabia)

Chapter Three

Material &Methodology

Chapter Three

Materials and Methods

3.1 Materials

3.1.1 Study population:

Sample including 145(27.1%) females and 391(72.9%) males .Participant's age were <30 days were 506(94.4%),31-60 days were 9(1.7%),61-90 days were 11(2.1%) ,and ages between 91-120 days were (10(1.9%).All infants were examined clinically and underwent Ultrasonographic of the hip. Infants who had teratology DDH or who had been diagnosed with DDH at another center and referred to our hospital for treatment were not included in the study.

3.1.2 Area, duration of study and data analysis:

This study was conducted in radiology department of United Doctors Hospitals (UDH) in kindom Saudi Arabia, Jeddah during the period from December 2011- December 2014. The hips of 536 newborn infants were examined by ultrasound routines screening program for hip joint at age 1 day up to 4 months.

3.1.3 Equipments

Ultrasonographic was performed with a 12-7.5,3.5 ,5 MHZ, but most examination were performed with 3MHZscan head by available patients documents CD by numbers hip normal ,abnormal, linear transducer (Toshiba, Sonoscape 2010, Philips 2012, volusum4000, Son layer SSA-270A, Japan).

3.2 Method:

3.2.1 Examination technique:

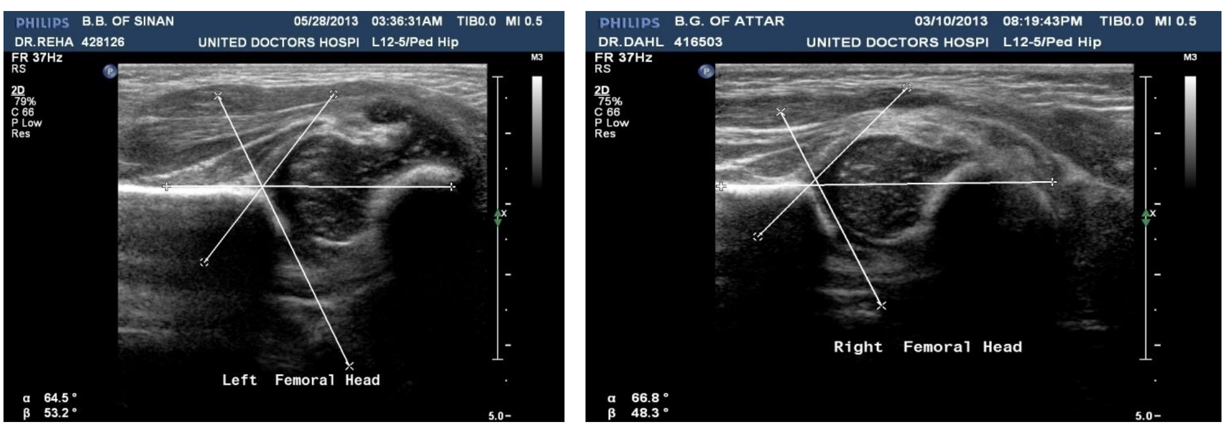
Several views of the infant hip were obtained by placing the transducer in the different position. Combination of two views was selected as being most reliable in the identification of the anatomical structures. In both views, the images are obtained by placing the transducer laterally in the region of the greater trochanter. In the view (transverse neutral, the infant is supine and the hip in the neutral position to identify the anatomical landmarks. The coronal flexion view, the ultrasound sector effectively scans a coronal section of the hip joint, the femur is in the flexed position and the transducer is rotated through 90 degree to identify anatomical landmarks.

3.2.2 Protocol and parameters

The sonograms were classified according to Graf's method in terms of the α and β angles. To classify the ultrasound participants according to hip instability, the following system was used: grade 1, slight capsular instability with no snapping sign and/or limitation of hip abduction to within 70° of the midline; grade 2, subluxated hip (Ortolani snapping); grade 3, dislocatable and reducible hip (dislocation sign); grade 4, fully dislocated, irreducible hip. This is the system described by Toni's with an additional criterion of limited hip abduction included in grade 1.

3.2.3 Measurement:

Graf's method using ultrasonography, by measuring the α and β angles and correlate the results with the anatomical findings related the hip.



A **B**

Figure (3.1) (A,B) example of measurement method: coronal image A:alfa 64.5, beta 55.2, B: Alfa 66.8 beta 48.3.

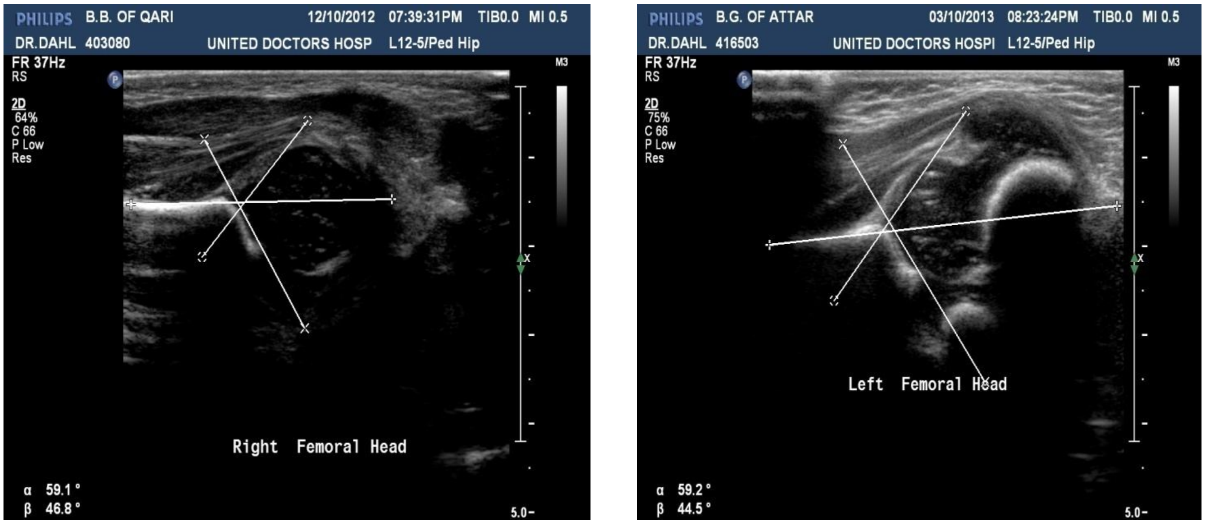


Figure (3.2) (A,B) example of measurement method: coronal image A:alfa 59, beta 48.8, B: Alfa 59.2 beta 44.5.

3.3 Tools:

3.3.1 Data Collection

Questionnaire was designed cantering data regarding the persona details: name, age, gender, clinical data, measurement, ultrasound of both hips.

3.3.2 Data analysis:

Analyzed using statistical package for social science program (SPSS), version 16 the frequency and percentage, all values expressed as means ± SD, maximum value expressed as means +_ SD ,maximum value, minimum value ,t –test was used to compare means. And p value of <0.05 was consider to be statistically significant. Graphics including linear relationship and pie graph were used.

Chapter Four

Results

Chapter Four

The Results

4.1 Results

Table No (4.1) Distribution of study sample according to Participant's gender

	Frequency	Percent (%)
Female	145	27.1
Male	391	72.9
Total	536	100.0 (%)

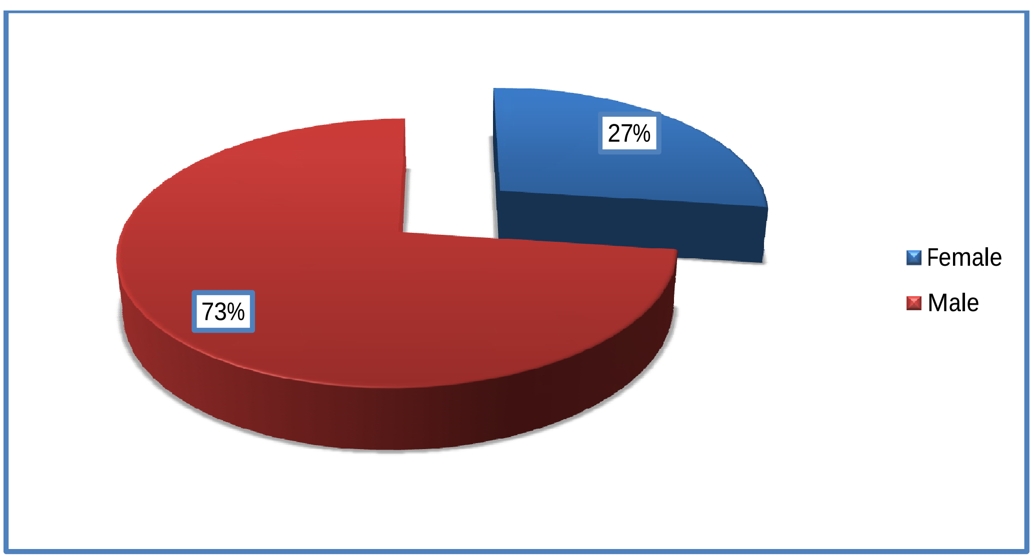


Figure No (4.1) Distribution of study sample according to Participant's gender

Table No (4.2) Distribution of study sample according to Participant's age

Age	Frequency	Percent (%)
<30 days	506	94.4
31-60 days	9	1.7
61-90 days	11	2.1
91-120 days	10	1.9
Total	536	100.0 (%)

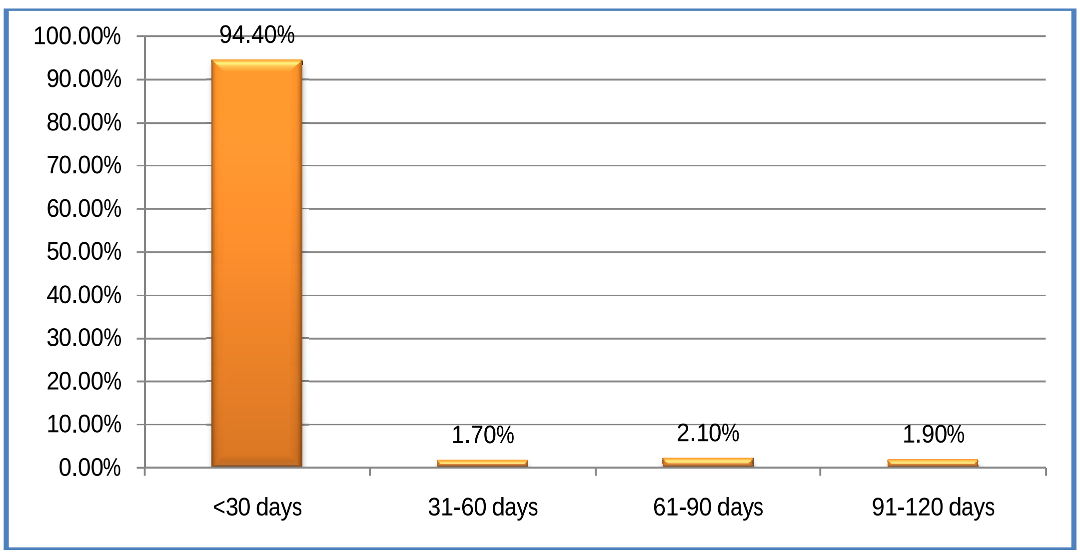


Figure No (4.2) Distribution of study sample according to Participant's age

Table No (4.3) Distribution of study sample according to Participant's Type1

	Frequency	Percent (%)
Yes	288	53.7
No	248	46.3
Total	536	100.0 (%)

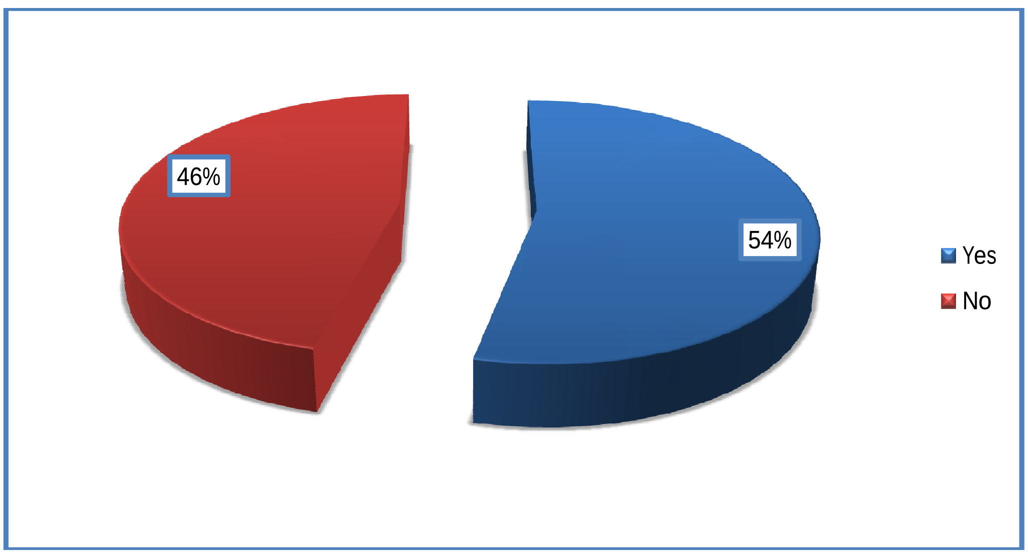


Figure No (4.3) Distribution of study sample according to Participant's Type1

Table No (4.4) Distribution of study sample according to Participant's Type2 Subluxate (unstable)

	Frequency	Percent (%)
< 3m 2a	27	20.3
" 2b >3m"	76	57.1
2c	30	22.6
Total	536	100.0 (%)

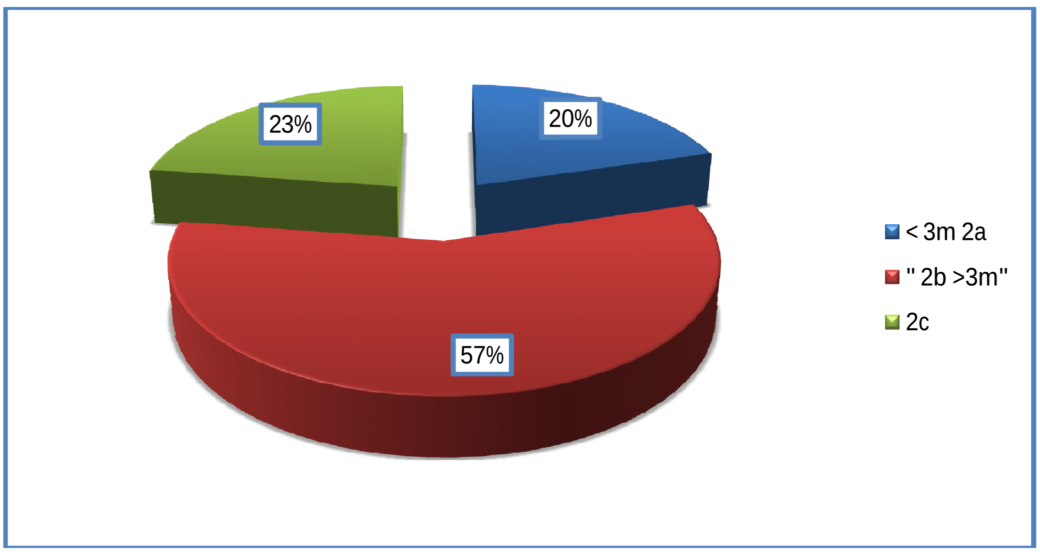


Figure No (4.4) Distribution of study sample according to Participant's Type2 Subluxate (unstable)

Table No (4.5) Distribution of study sample according to Participant's Type3

	Frequency	Percent (%)
Yes	45	8.4
No	491	91.6
Total	536	100.0 (%)

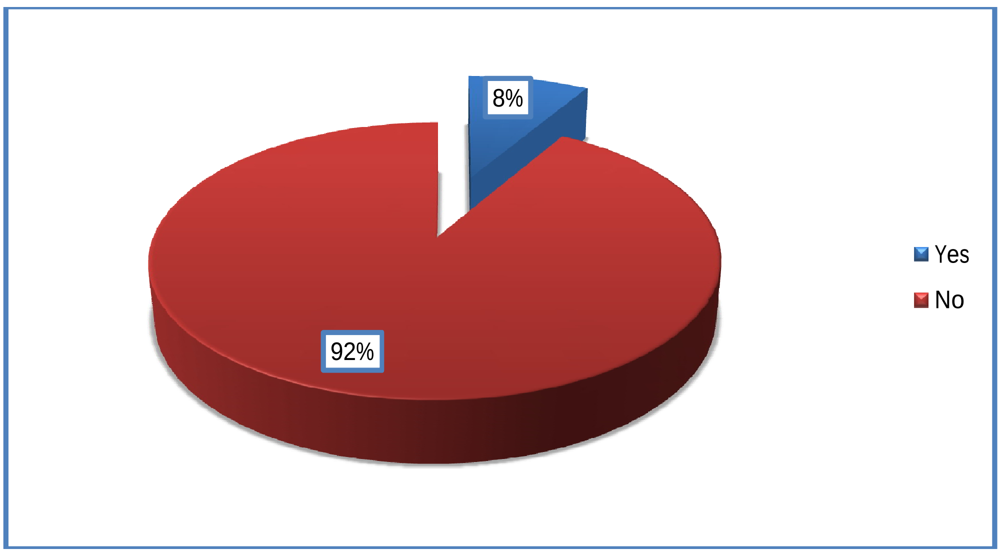


Figure No (4.5) Distribution of study sample according to Participant's Type3

Table No (4.6) Distribution of study sample according to Participant's Type4

	Frequency	Percent (%)
Yes	33	6.2
No	503	93.8
Total	536	100.0 (%)

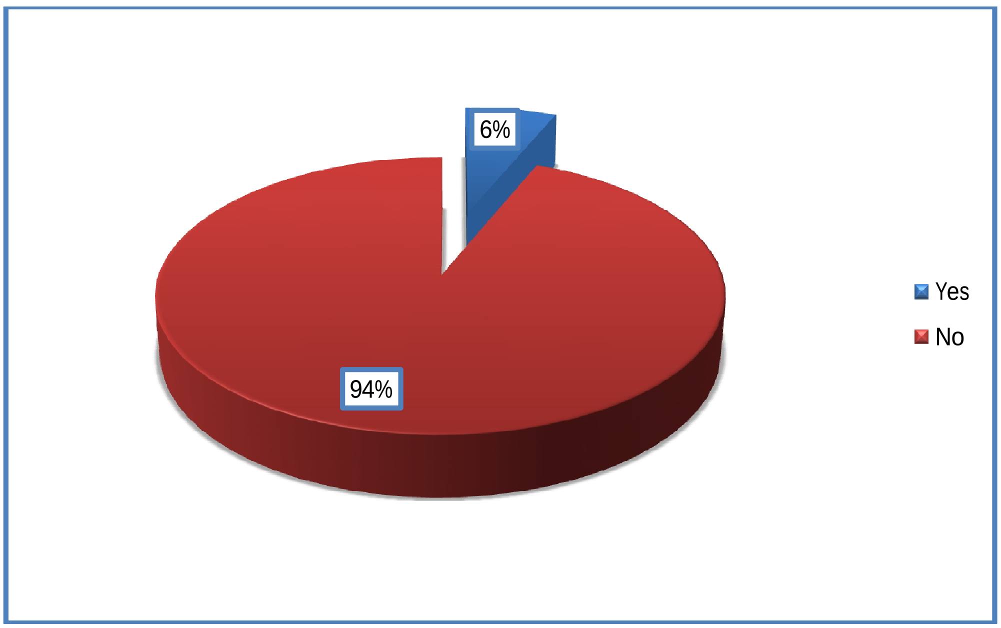


Figure No (4.6) Distribution of study sample according to Participant's Type4

Table No (4.7) Distribution of study sample according to DDH Type

Type1 Frequency%	Type 2	Frequency %	Type3 Frequency%	Type4 Frequency %
288 53.7%	2a < 3m 27(20.3%)		45 8.4%	33 6.2%
-	2b >3m 76(57.1%)		-	-
-	2c 30(22.6%)		-	-

Table No (4.8) Type of dislocation cross tabulated with Age/days

P-value	Type		Age/days				Total
			<30 days	31-60 days	61-90 days	91-120 days	
0.018	***Type1***	Count	280	2	4	2	288
		% of Total	52.2%	0.4%	0.7%	0.4%	53.7%
0.000	***Type2***	Count	9	4	5	9	27
	2a < 3m	% of Total	6.8%	3.0%	3.8%	6.8%	20.3%
	2b >3m	Count	75	0	1	0	76
		% of Total	56.4%	0.0%	0.8%	0.0%	57.1%
	2c	Count	29	1	0	0	30
		% of Total	21.8%	0.8%	0.0%	0.0%	22.6%
0.613	***Type3***	Count	44	0	1	0	45
		% of Total	8.2%	0.0%	0.2%	0.0%	8.4%
0.005	***Type4***	Count	30	3	0	0	33
		% of Total	5.6%	0.6%	0.0%	0.0%	6.2%

Table (4.9) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the clinical results

P-value	Type		Clinical Data					Total
			routine exam	CDH	hip click	check up	DDH	
0.333	***Type1***	Count	130	66	87	2	1	286
		% of Total	24.3%	12.4%	16.3%	0.4%	0.2%	53.6%
0.077	***Type2***	Count	22	3	2	0	-	27
	2a < 3m	% of Total	16.5%	2.3%	1.5%	0.0%	-	20.3%
	" 2b	Count	36	19	20	1	-	76
	>3m"	% of Total	27.1%	14.3%	15.0%	0.8%	-	57.1%
	2c	Count	17	4	9	0	-	30
		% of Total	12.8%	3.0%	6.8%	0.0%	-	22.6%
0.000	***Type3***	Count	5	22	18	0	0	45
		% of Total	0.9%	4.1%	3.4%	0.0%	0.0%	8.4%
0.798	***Type4***	Count	15	10	8	0	0	33
		% of Total	2.8%	1.9%	1.5%	0.0%	0.0%	6.2%

Table (4.10) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the DDH Risk Factor (Family History, Breach History Pregnancy)

P-value	Type		DDH Risk Factor		Total
			With	Without	
0.062	***Type1***	Count	164	90	254
		% of Total	33.8%	18.6%	52.4%
0.000	2a < 3m	Count	25	2	27
		% of Total	19.5%	1.6%	21.1%
	2b >3m	Count	36	38	74
		% of Total	28.1%	29.7%	57.8%
	2c	Count	14	13	27
		% of Total	10.9%	10.2%	21.1%
0.000	***Type3***	Count	9	36	45
		% of Total	1.9%	7.4%	9.3%
0.223	***Type4***	Count	22	9	31
		% of Total	4.5%	1.9%	6.4%

Table (4.11) characterization of hip joint development in different types of DDH

	Type1	Type2	Type3	Type4
Acetabulum Development	**Yes 179(49.6%)** **No 24(6.6%)** *P-value=0.002*	**Yes 73(82.0%)** **No 16(18.0%)** P-value=0.725	**Yes 2(0.6%)** **No 13(3.6%)** P-value=0.000	**Yes 2(0.6%)** **No 21(5.8%)** P-value=0.000
Femoral Head Within Acetabuler cavity	**In 194(53.6%)** **Out 8(2.2%)** *P-value=0.000*	**In 71(81.6%)** **Out 16(18.4%)** *P-value=0.679*	**In 2(0.6%)** **Out 18(5.0%)** *P-value=0.000*	**In 2(0.6%)** **Out 23(6.4%)** *P-value=0.000*
Ischium Development	**Yes 191(35.8%)** **No 97(18.2%)** *P-value=0.000*	**Yes 65(49.2%)** **No 67(50.8%)** *P-value=0.239*	**Yes 3(0.6%)** **No 42(7.9%)** *P-value=0.000*	**Yes 7(1.3%)** **No 25(4.7%)** *P-value=0.000*
Illiac line capsule, acetabular cartage Femoral Head Ligament Teres	**Yes 189(54.8%)** **No 7(2.0%)** *P-value=0.000*	**Yes 62(80.5%)** **No 15(19.5%)** *P-value=0.977*	**Yes 2(0.6%)** **No 17(4.9%)** *P-value=0.000*	**Yes 3(0.9%)** **No 21(6.1%)** *P-value=0.000*
Physiologic immature equivocal	**Yes 0(0.0%)** **No 288(53.7%)** *P-value=0.000*	**Yes 6(4.5%)** **No 21(15.8%)** *P-value=0.017*	**Yes 0(0.0%)** **No 45(8.4%)** *P-value=0.006*	**Yes 3(0.6%)** **No 30(5.6%)** *P-value=0.450*
Acetabular labrotary	**Yes 188(56.3%)** **No 7(2.1%)** *P-value=0.000*	**Yes 16(21.1%)** **No 4(5.3%)** *P-value=0.959*	**Yes 2(0.6%)** **No 10(3.0%)** *P-value=0.000*	**Yes 2(0.6%)** **No 22(6.6%)** *P-value=0.000*

Table (4.12) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the DDH Side of dislocation

Crosstab

P-value=0.000			Side Of Dislocation			Total
			RT Only	LT Only	Bilateral	
Type1	Yes	Count	13	4	98	115
		% of Total	4.2%	1.3%	31.9%	37.5%
	No	Count	82	40	70	192
		% of Total	26.7%	13.0%	22.8%	62.5%
Total		Count	95	44	168	307
		% of Total	30.9%	14.3%	54.7%	100.0%
P-value=0.000			Side Of Dislocation			Total
			RT Only	LT Only	Bilateral	
Type2 Subluxate (unstable)	< 3m 2a	Count	11	4	6	21
		% of Total	10.3%	3.7%	5.6%	19.6%
	" 2b >3m"	Count	14	5	46	65
		% of Total	13.1%	4.7%	43.0%	60.7%
	2c	Count	9	8	4	21
		% of Total	8.4%	7.5%	3.7%	19.6%
Total		Count	34	17	56	107
		% of Total	31.8%	15.9%	52.3%	100.0%
P-value=0.000			Side Of Dislocation			Total
			RT Only	LT Only	Bilateral	
Type 3	Yes	Count	27	7	4	38
		% of Total	8.8%	2.3%	1.3%	12.4%
	No	Count	68	37	164	269
		% of Total	22.1%	12.1%	53.4%	87.6%
Total		Count	95	44	168	307
		% of Total	30.9%	14.3%	54.7%	100.0%
P-value=0.010			Side Of Dislocation			Total
			RT Only	LT Only	Bilateral	
Type4	Yes	Count	14	5	7	26
		% of Total	4.6%	1.6%	2.3%	8.5%
	No	Count	81	39	161	281
		% of Total	26.4%	12.7%	52.4%	91.5%
Total		Count	95	44	168	307
		% of Total	30.9%	14.3%	54.7%	100.0%

Table (4.13) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the Gender

Crosstab

P-value=0.832			Gender		Total
			Male	Female	
Type1	Yes	Count	79	209	288
		% of Total	14.7%	39.0%	53.7%
	No	Count	66	182	248
		% of Total	12.3%	34.0%	46.3%
Total		Count	145	391	536
		% of Total	27.1%	72.9%	100.0%
P-value=0.463					
Type2 Subluxate (unstable)	< 3m 2a	Count	8	19	27
		% of Total	6.0%	14.3%	20.3%
	" 2b >3m"	Count	27	49	76
		% of Total	20.3%	36.8%	57.1%
	2c	Count	7	23	30
		% of Total	5.3%	17.3%	22.6%
Total		Count	42	91	133
		% of Total	31.6%	68.4%	100.0%
P-value=0.772					
Type3	Yes	Count	13	32	45
		% of Total	2.4%	6.0%	8.4%
	No	Count	132	359	491
		% of Total	24.6%	67.0%	91.6%
Total		Count	145	391	536
		% of Total	27.1%	72.9%	100.0%
P-value=0.236					
Type4	Yes	Count	6	27	33
		% of Total	1.1%	5.0%	6.2%
	No	Count	139	364	503
		% of Total	25.9%	67.9%	93.8%
Total		Count	145	391	536
		% of Total	27.1%	72.9%	100.0%

Chapter Five

Discussion, Conclusions

&

Recommendation

Chapter Five

Discussion, Conclusions and Recommendation

5.1 Discussion:

Table (4.1) showed the distribution of study sample according to DDH Type. The most common affected age were ages<30 days, 280 were of type1, 9 were 2a < 3m, 75 were 2b >3m and 29 were 2c. 44 were type 3 and 30 were type 4 with significant relation with age at p=0.018, 0.000, 0.005 for type 1, 2, and 4 respectively as presented in table (4.8).

Table (4.9) shows the diagnosis and classification of hip dysplasia by ultrasound cross tabulated with the clinical results the clinical examinations showed no consistency between the clinical findings as CHD,DDH, Hip click or other findings with ultrasound results as type1, 2 and 4.

The clicking hip, DDH, CHD are found in babies of the high-risk factors there is general agreement on the importance of breech position, postural deformities and family history. Table (4.10) showed the risk factor cross tabulated with the DDH type. The risk of an abnormality on ultrasound for each of these was shown to be increased significantly in type 2,3, this supports the opinion that a clicking hip should never be ignored (Cunningham et al 1984) (Cunningham KT et al 1994). Of the 70 babies which were abnormal on ultrasound, 9 were Graf types III showing definite evidence of subluxation or dislocation. These were usually clinically detectable; it could be argued that the vast majority would have not been detected without ultrasound.

The remainder 133 babies were Graf type II; these are usually clinically normal and, in our series, were found most commonly in the ‘clicking’ 20(15.0%) and CHD 19(14.3%).

There is significant relation between type 2 and 3 with the risk factor table (4.10), however in type 1and 4 there is no significant relation with the presence of risk factor, it was mentioned that more than 60% of infants with DDH have no identifiable risk factors. [Standing Medical Advisory Committee et al 1986] Infants with the following features have been considered to be at high risk for DDH, although these risk factors have not been validated: first-degree relative with DDH, breech delivery or clinical evidence of joint instability. [Standing Medical Advisory Committee et al 1986, Rosendahl K et al 1994, Garvey M et al 1992, Jones DA et al 1992, Jones DA et al 1989).

Less widely accepted risk factors include persistent “click” on clinical examination, congenital postural or foot deformities, and fetal growth retardation. (Standing Medical Advisory Committee et al 1986, Garvey M et al 1992, Jones DA et al 1989) Certain ethnic and geographic populations have also been identified as being at high risk for DDH including Canadians (Walker JM. et al 1979).

When characterizing hip joint and its development in different types of DDH, results showed that the acetabulum is well developed in type 1 and least developed in type 3 and 4 significantly

the femoral head is outside the acetabuler cavity in both type 3 and 4 while it was found inside the groove in type 1 the ischium is found to be well developed in type1 while in type 3and4 most of the cases were not developed .Normal Illiac line capsule, acetabular cartilage, Femoral Head Ligament were detected in type 1 where significant changes were detected in type 3 and 4 this was presented in table (4.11)

There is significant relation between types 1 and 2, 3, 4 with side of dislocation it was mentioned that mostly right side, left side, bilateral with p value 0.000, 0.000, 0.000, 0.010, Table (4.12). Compared to another study mentioned that side of dislocation it can happens only to the left side related to the risk factors. (Rosendahl K et al 1998)

Highly prevalence diagnosis of hips dysplasia by ultrasound related with gender in our study in both females and males with p value 0.832, 0.463, 0.772, 0.236 with types 1,2,3,4 consequently. Table (4.7). Compared to another study mentioned females is high degree of dislocation (NY Boo, T Rajaram 1989)

When comparing the clinical examination results /methods with ultrasound methods , Studies showed that the Ortolani and Barlow clinical tests were done during the first several months of life and testing for DDH in older infants and children have always been applied (Patel H et al 2001). The Ortolani test relocates the dislocated hip into the normal acetabular position and is accompanied with a palpable “clunk.” The Barlow test is a challenging test of dislocation of the hip joint. (Weinstein SL et al 1996, Tachdjian MO et al 1990, Mooney JF et al 1995) For the diagnosis of hip dislocation, the Barlow test has been associated with a low positive predictive value. [Burger BJ et al 1990] When the Ortolani and Barlow tests are combined; they show high specificity in the diagnosis of hip dislocation or subluxation. (Burger BJ et al 1990, Anderson JE et al 1995) as well the tests become less sensitive in older infants, in part because of the larger size and muscle bulk and the development of hip contractures. (Harcke HT 1999)Serial clinical examinations appear to be an effective screening strategy. However in the clinical screening period, the detection rate of hip joint instability at birth has ranged from 5 to 20 cases per 1000 infants, depending mainly on age at testing and examiner experience. (Burger BJ et al 1990, Godward S et al 1998) With serial clinical examination, the operative rate for DDH has decreased by more than 50%, (Burger BJ et al 1990, Godward S et al 1998) This favorable decline needs to be balanced with the increase in false-positive results and false negative results . These facts were consistent with our results; therefore ultrasongraphy should be applied together with the clinical approach .Infants who underwent ultrasound screening had both morphologic and dynamic hip testing One ultrasonographic study showed that Infants were treated with abduction splints. Hips with dysplastic morphology were also treated, whether or not there were clinical findings of instability. Mildly dysplastic hips were treated only if they were found to be unstable clinically or ultrasonographically. Hips with only ultrasound evidence of instability were not treated. (Clarke NMP 1992)

Of significance, ultrasound screening identified many cases whom were clinically normal infants. Comparing results of ultrasound screening with those of clinical screening; selective ultrasound screening alone did not decrease the value of diagnosis of DDH compared with clinical screening but it considered as harmonizing for proper and accurate diagnosis.

Regarding the results ultrasonography has documented its ability to detect abnormal position, instability, and dysplasia not evident on clinical examination, screening of all infants at. Consequently, the use of ultrasonography is recommended as an adjunct to the clinical evaluation. It is the technique of choice for clarifying a physical finding, assessing a high-risk infant and monitoring DDH as it is observed or treated. Used in this selective capacity, it can guide treatment and may prevent overtreatment.

According to the Graf ultrasonographic hip classification system, the α and β angles are the quantitative indicators of the bony and cartilage acetabular roofs, respectively .The α angle mainly determines the hip type and the other parameters, such as the age of the patient, β angle value, β angle value under stress, course of the perichondrium of the cartilage acetabular roof and structural changes in the cartilage roof, give particular differentiations [Graf R (2006) Hip sonography).

In the current study, Infants who had mature hip joints (Graf type Ia or Ib) were exempted from follow-up. Infants with physiologically immature hips (Graf type IIa) were followed up with ultrasound until they were three months old, and if maturity was not complete at this time, the hip was classified as Graf type IIb. Infants with Graf type IIb hips as well as infants who on the initial ultrasound had Graf type IIc, type D, type III or type IV hips were assigned a diagnosis of DDH.

In the current study US provided detailed imaging of the hip. The current study applies the guidance mentioned by the American Institute of Ultrasound in Medicine and the American College of Radiology published guideline for the standardized performance of the infantile hip ultrasonographic examination.(American Institute of Ultrasound in Medicine et al 2009).

Results showed that the static ultrasonography demonstrated coverage of the femoral head by the cartilaginous acetabulum (α angle).Alfa angle showed significant difference in the measurement done when the acetabuler labrum is developed or not .

The Graf method was performed in the lateral decubitus position as mentioned by Graf (Graf R (2006) Hip sonography) Before starting to classify the hip joint, anatomical landmarks were identified to be evaluated ; femoral head, hip joint capsule, acetabular labrum, acetabular hyaline cartilage, acetabular bony roof and acetabular bony rim , when the sonogram contains the bony ilium in the depth of the acetabular fossa, as well as an apparent acetabular labrum and a straight iliac wing contour,this means that it has a standard plane.

Ultrasound detected some instable, sublaxed and dislocated hips which were not diagnosed at birth by clinical examination. Those cases present late with the prospect of lasting disability. This applied ultrasound of neonatal hips makes it possible to late-presenting DDH.

There is significant association between the β angle and acetabulum development, normality of the acetabuler labrum and normal presence of femoral head within the acetabuler cavity, at p = 0.000,0.000,0.000 however the α angle should be considered if there is abnormal presentation of the labrum (table 4.2) . Ischia development and acetabular bony roof , acetabular bony rim , joint capsule , acetabular hyaline cartilage and femoral head ligament normality were well correlated with the β angle at p= 0.006 and 0.000 (table 4.3).The results of the current study revealed that it was better to measure the α and β angle than to define the hip morphology and pathology alone ,this was consistent with other previous studies [Peterlein CD et al 2010, Irha E et al 2004, Jomha NM et al 2011)

Our experience that Graf class as deficient bony roof/bony roof angle α and worse hips can be detected by clinical examination in experienced hands, but the risk of missing the diagnoses is considerably high by performing clinical examination alone as mentioned previously by (Omerogˇlu H and Koparal S ;2010) (Omerogˇlu H et al 2011). The results of another study revealed that there was still no strong evidence for the diagnostic accuracy of hip ultrasonography as a screening tool (Woolacott NF et al 2012). However our judgment that ultrasonographic hip screening is better than clinical hip screening alone, even if the clinical examination is performed by an experienced physician because of its ability to measure the angles objectively and evaluation the surrounding bony anatomy subjectively

5.2 CONCLUSION

Clinical examination still has diagnostic value in newborn as it is the first tract for referring the pediatrics for hip screening, but it needs highly experienced hands, hip ultrasonography is found to be accurate diagnostic tool in developmental DDH as we measured the α and β angles .It is better to perform the ultrasonographic hip screening within the early years. An effective hip ultrasonography method should include accurate, quantitative and consistent definitions for α and β angles for obtaining accurate diagnosis and managing the hip dysplasia in a proper way. Application of ultrasonography using Graf method meets the necessities for identification of the hip anatomy ,morphology and pathology .Our study recommended to screen the newborn hip beside the clinical examination, in order to detect the dysplasia as early as possible, so that early treatment can took place.

5.3Recommendation

1\ All infants up to4 months should be done routinely screening programs of developmental dysplasia of hips joint by ultrasounds.

2\ All the primary health centers and hospitals should be equipped well by high quality ultrasound machines. Physician and Technologist should be good qualified.

3\ Every infants hips should be routinely examined by ultrasound at first age at birth with or without high risk factors: Breech presentation, Positive Family history, Gender and Birth weight <2500 kg.

4\ It is the technique of choice for clarifying a physical finding assessing a high infant risk and monitoring DDH, it can guide treatment and may prevent over treatment.

5\ Also all the peoples should be oriented about the usefulness of the scanning by ultrasound repeatable.

6\ And also oriented about the factors that can increase the risk of hip dysplasia. Swaddling use, first pregnancy, labor of delivery, primperity, Oligo hydramnios.

7\ Ultrasound examination is a more a valuable tool in the imaging of hips joint, improved diagnosis accuracy in congenital dislocation of the hips.

8\ All infants should be examined by ultrasound bilaterally, not one side only.

9\ Further studies about the use of ultrasound compare to x-ray is recommended.

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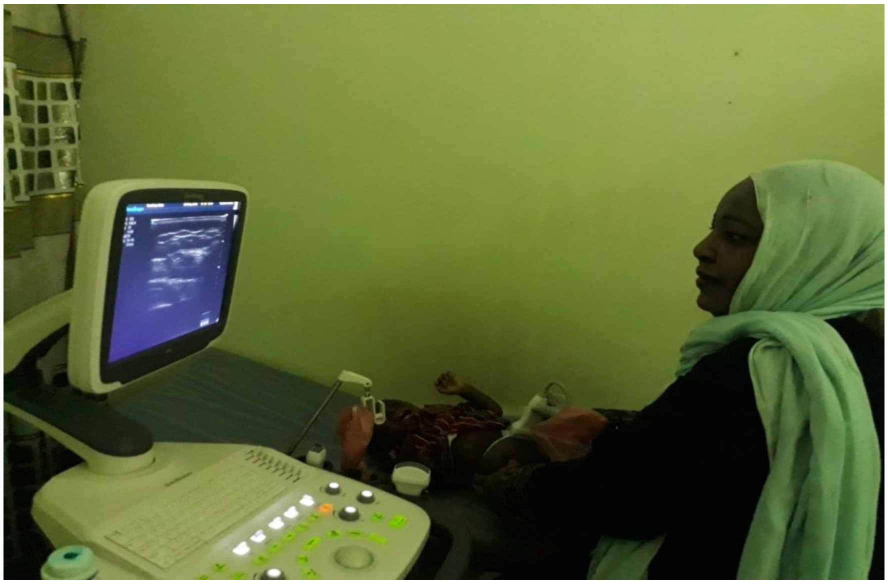
Appendices

Appendix (1)

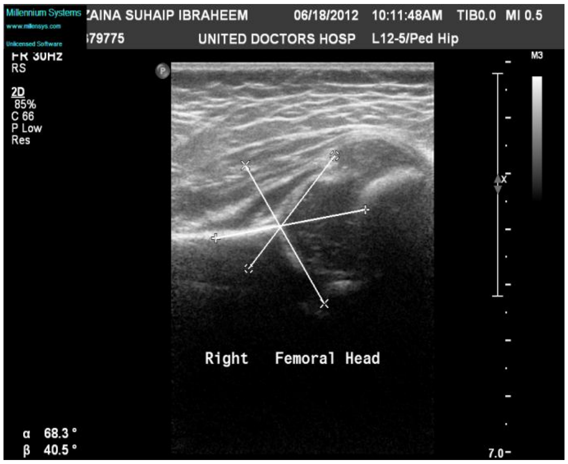
Ultrasound equipment:



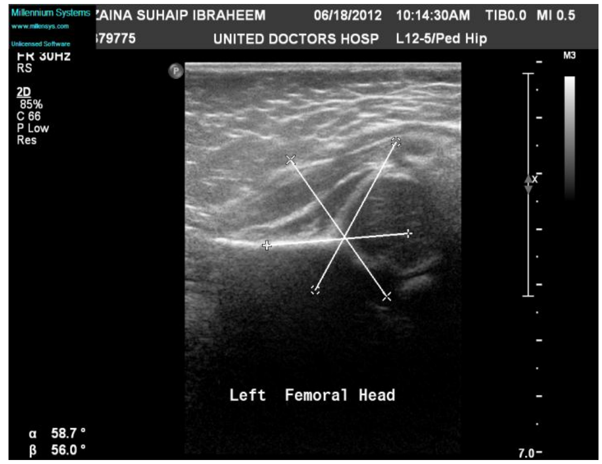
The research during a playing the protocol of Developmental Hip Dysplasia

Appendix (2)

Cases

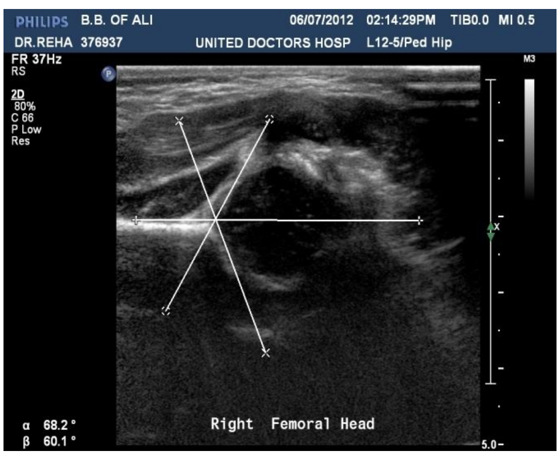


A



B

Image No (1): A,B show coronal view, type 1, baby boy, 1 day, bilateral hip click, α 58.7, β 56, u/s finding show normal hip joint.



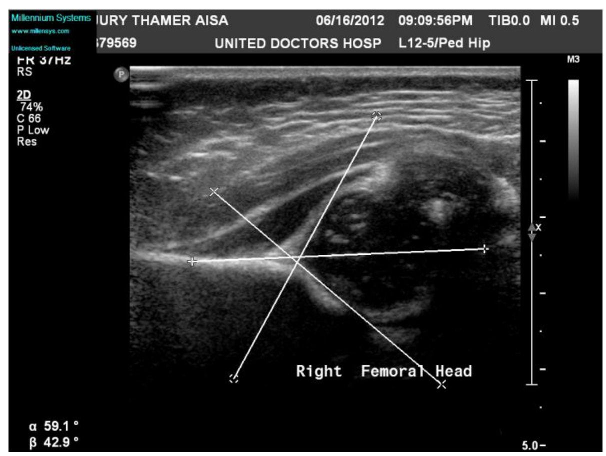
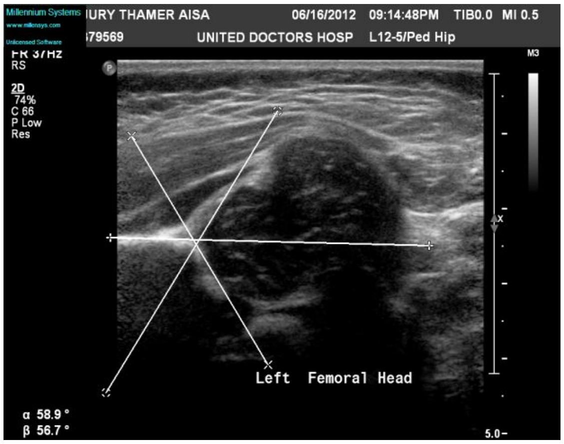


Image No (2) Coronal view, type 1, baby boy, 3 days,? right hip click, α 68.2, β 60.1, u/s finding show subluxed hip joint

Image No (3) Coronal view, type 1, baby boy, 3 days,? right hip click, α 59.1, β 42.9, u/s finding show normal hip joint.



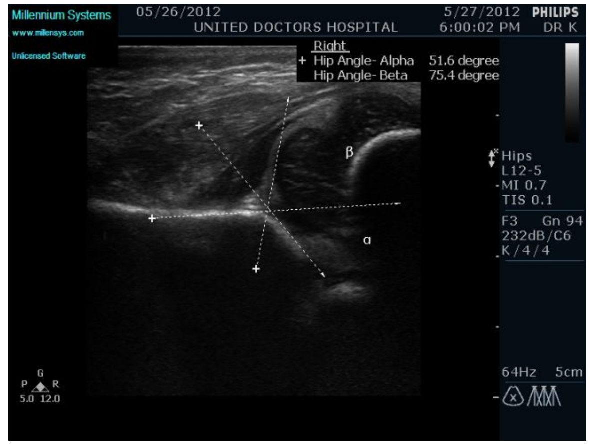
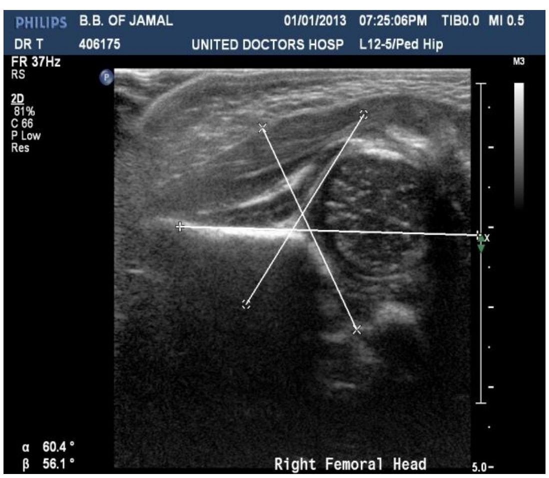
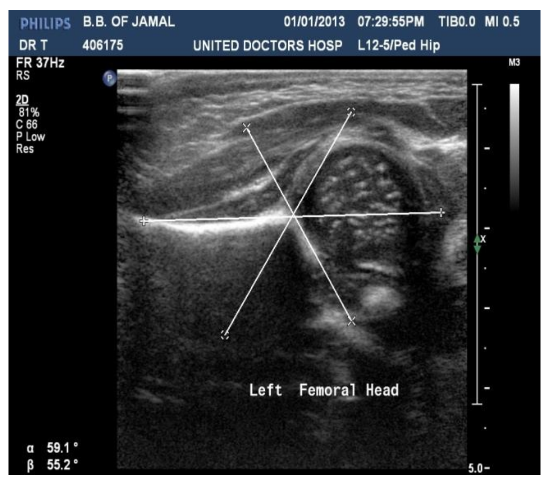


Image No (4) Coronal view, type 1, baby boy, 3 days,? left hip click, α 58.9, β 56.7, u/s finding show normal hip joint.

Image No (5) Coronal view, type 1, baby boy, 3 days,? right hip click, α 51.6, β 75.4, u/s finding show right hip dislocation.

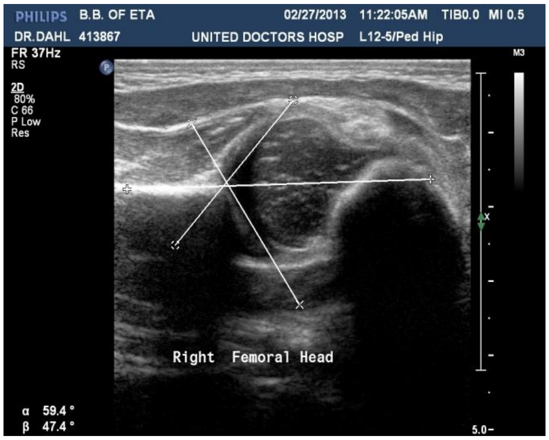


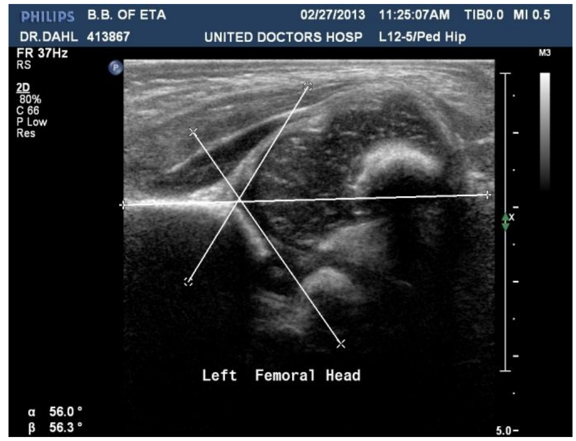
A



B

Image No (6) A,B shows coronal view, type 1, baby boy, 8 days, bilateral hip click, right α 60.4, β 56.1, left α 59.1, β 55.2 u/s finding show normal hip joint



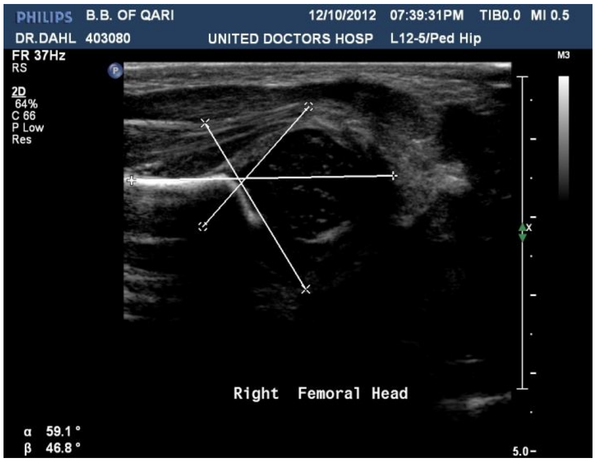


A B

Image No (7) A,B shows coronal view, type 1, baby boy, 15 days,? bilateral hip click, right α 59.4, β 47.4, left α 56, β 56.3 u/s finding show normal hip joint

A B

Image No (8) A,B shows coronal view, type 1, baby boy, 11 days,? bilateral hip click, right α 61.8, β 54.9, left α 60.5, β 56.6 u/s finding show normal hip joint



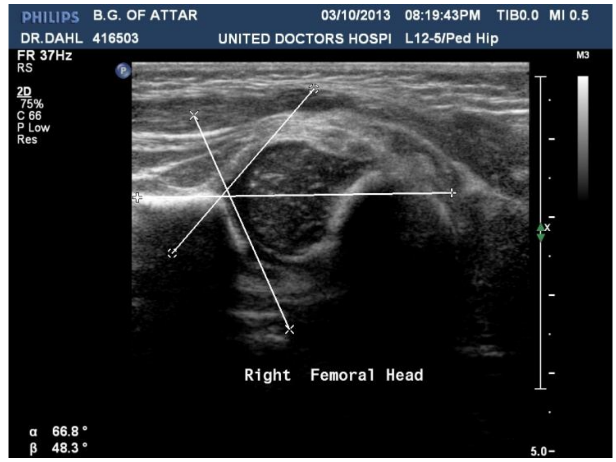


Image No (9) Coronal view, type 1, baby boy, 25 days,? right hip click, α 59.1, β 46.8, u/s finding show normal hip joint.

Image No (10) Coronal view, type 2, baby girl, 2 days,? right hip click, α 66.8, β 48.3, u/s finding show normal hip joint

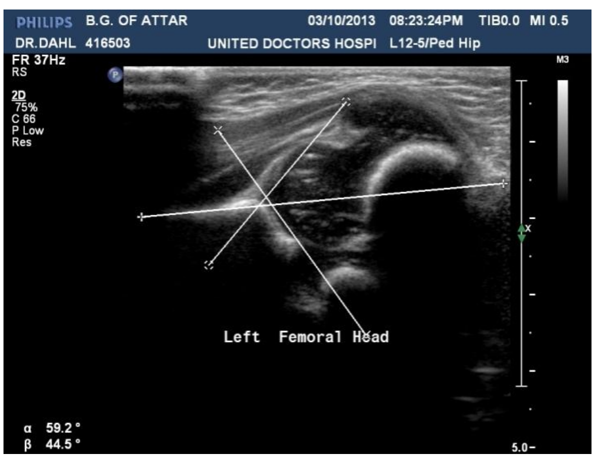


Image No (11).Coronal view, type 1, baby girl, 2 days,? left hip click, α 59.2, β 44.5, u/s finding show normal hip joint.

Image No (12) Coronal view, type 2, baby girl, 19 days,? right hip click, α 54.9, β 49, u/s finding show normal hip joint.

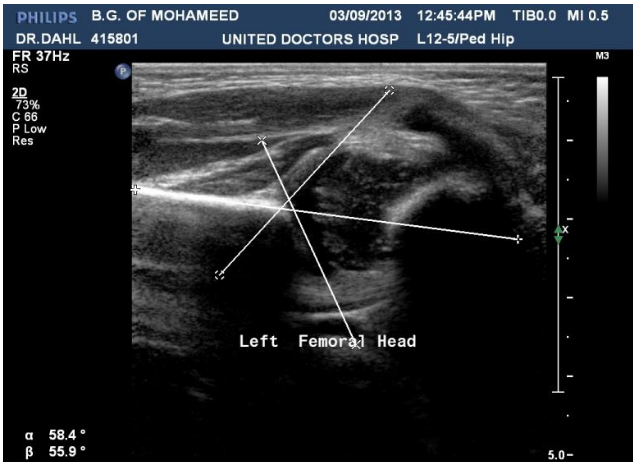
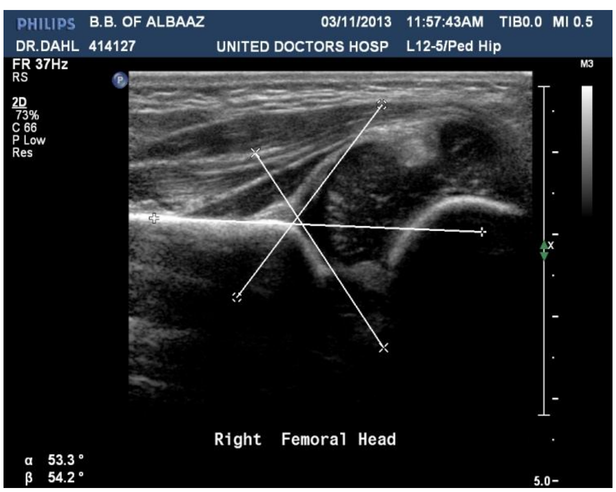
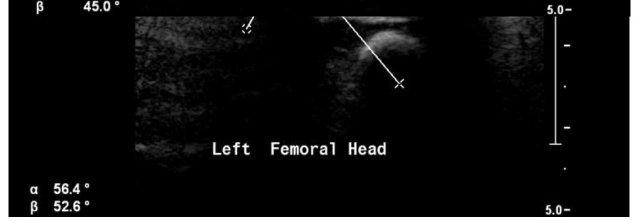


Image No (13). Coronal view, type 2, baby girl, 19 days,? left hip click, α 58.4, β 55.9, u/s finding show normal hip joint

Image No (14) Coronal view, type 2, baby girl, 1 day,? left hip click, α 59.7, β 45.0, u/s finding show subluxed hip joint





A

B

Image No (15) A,B shows coronal view, type 2, baby boy, 3 days,? bilateral hip click, right α 53.3, β 54.2, left α 56.4, β 52.6 u/s finding show subluxed hip joint

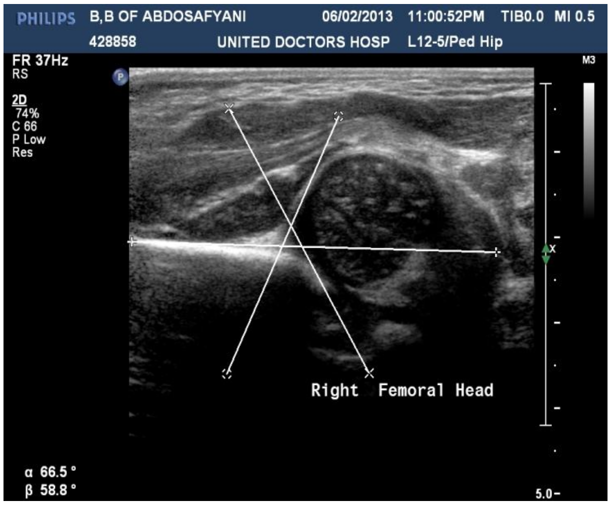


Image No (16). Coronal view, type 1, baby boy, 12 days,? Breech ,right hip click α 66.5, β 58.8, u/s finding show normal hip joint

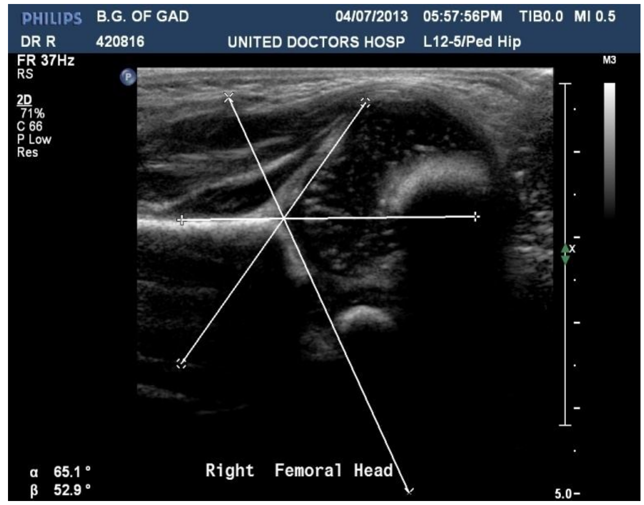
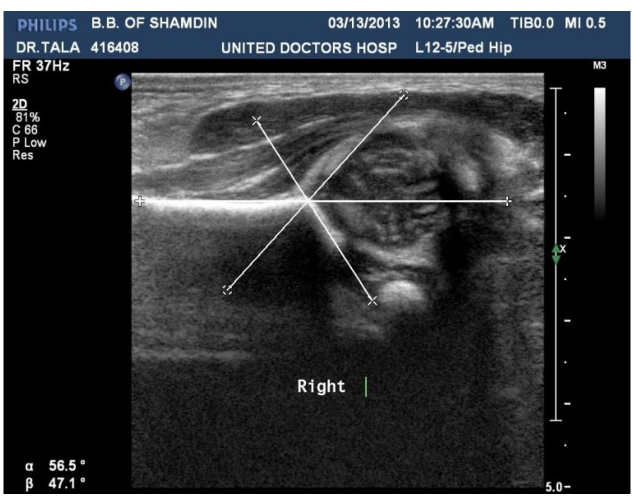


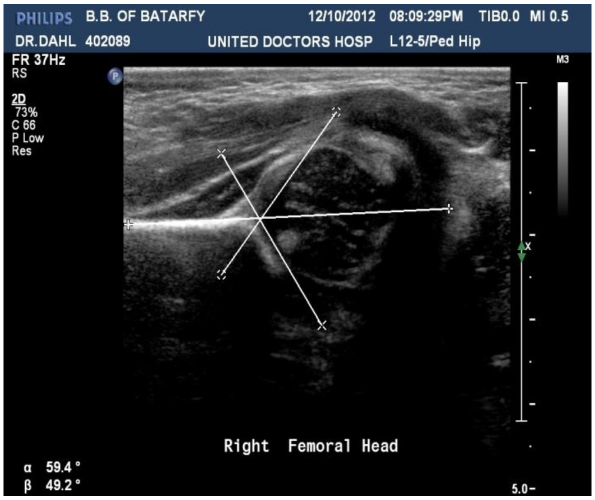
Image No (17). Coronal view, type 1, baby girl, 2 day,? right hip click, α 65.1, β 52.9, u/s finding show subluxed hip joint



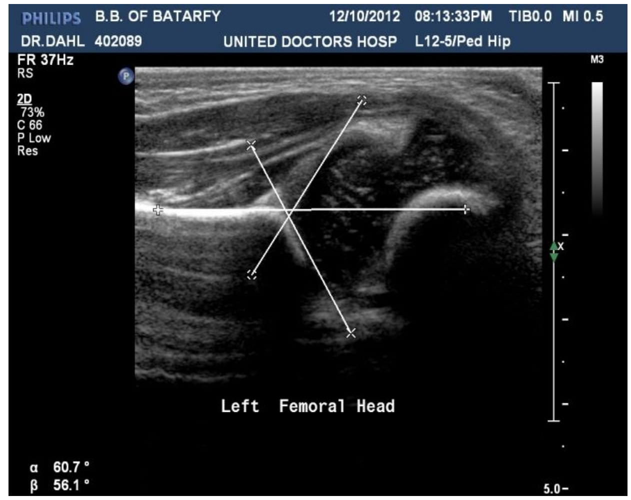
A

B

Image No (18) A, B shows Coronal view, type 2, baby boy, 4 days,? bilateral hip click, right α 56.5, β 47.1, left α 58.1, β 47.5 u/s finding show normal hip joint

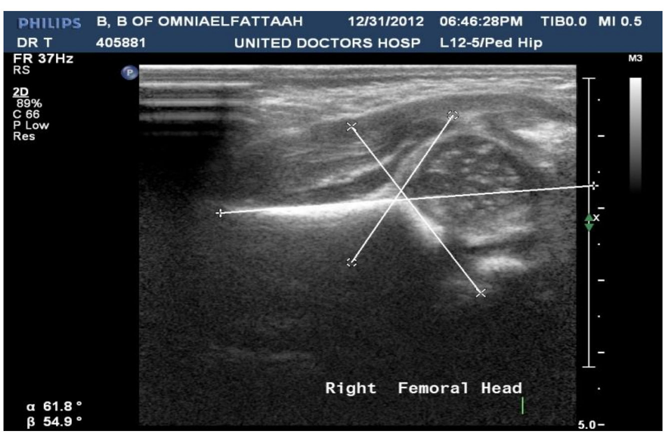


A

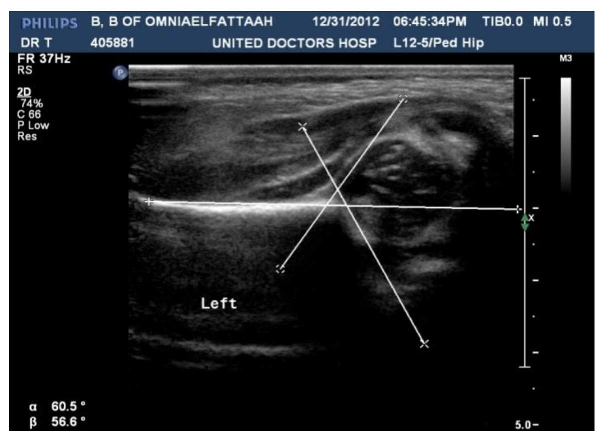


B

Image No (19) A, B shows Coronal view, type 1, baby boy, 7 days,? bilateral hip click, right α 59.4, β 49.2, left α 60.7, β 56.1 u/s finding show normal hip joint



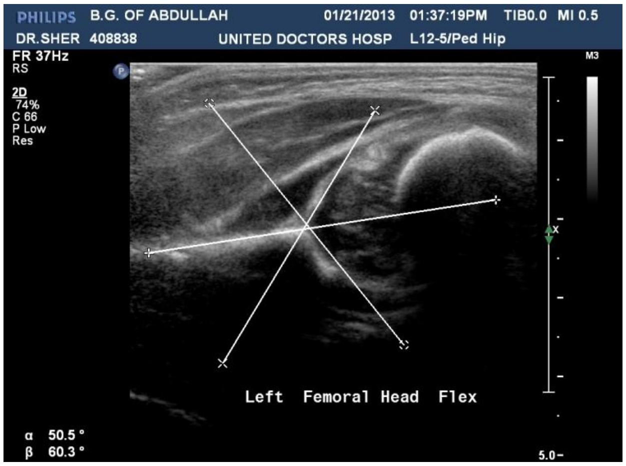
A



B

Image No (20).Coronal view, type 2, baby boy, 9 days,? right hip click, α 61.8, β 54.9, u/s finding show normal hip joint

Image No (21). Coronal view, type 2, baby boy, 1 day,? left hip click, α 60.5, β 56.6, u/s finding show subluxed hip joint



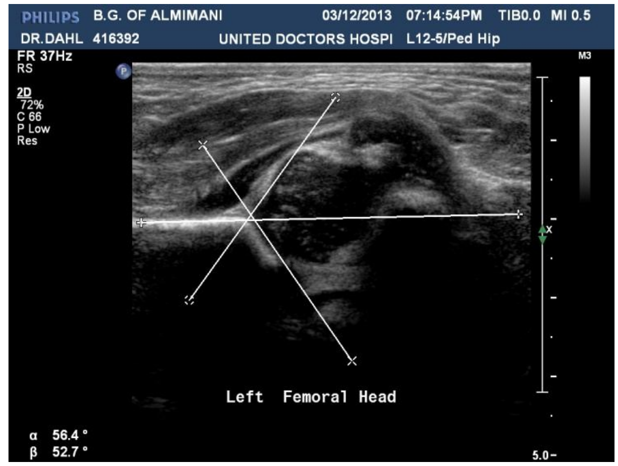
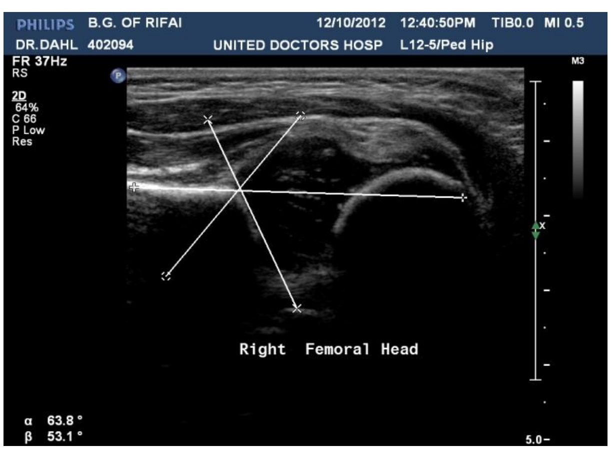
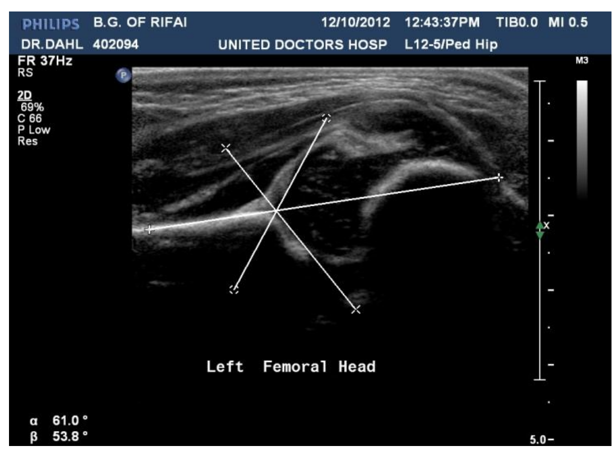


Image No (22). Coronal view, type 2, baby girl, 3 days,? Left hip click, α 50.5, β 60.3, u/s finding show subluxed hip joint.

Image No (23). Coronal view, type 2, baby girl, 1 day,? left hip click, α 56.4, β 52.7, u/s finding show subluxed hip joint



A



B

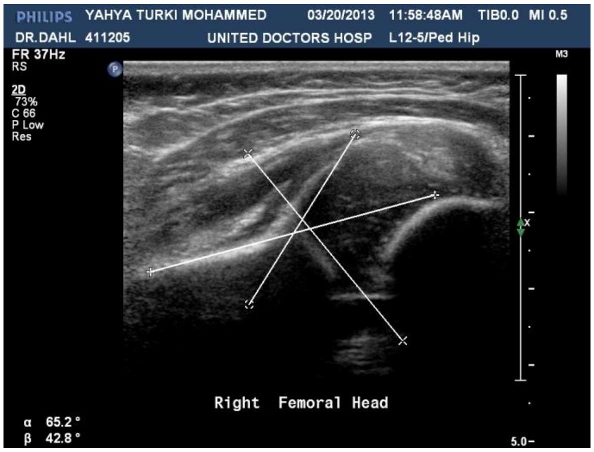
Image No (24) A, B shows Coronal view, type 2, baby girl, 7 days,? bilateral hip click, right α 63.8, β 53.1, left α 61.0, β 53.8 u/s finding show normal hip joint

A B

Image No (25) A, B shows Coronal view, type 1, baby boy, 11 days,? bilateral hip click, right α 62.7, β 55.7, left α 64.5, β 53.2 u/s finding show normal hip joint

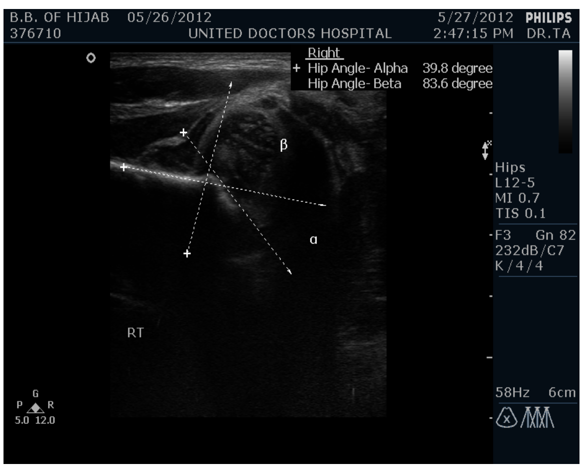
A B

Image No (26) A, B shows Coronal view, type 2, baby girl, 2 days,? bilateral hip click, right α 61.0, β 55.8, left α 71.8, β 53.0 u/s finding show left hip dislocation .



A B

Image No (27) A, B shows Coronal view, type 3, baby boy, 1 day,? bilateral hip click, right α 65.2, β 42.8, left α 68.3, β 35.9 u/s finding show bilateral hip dislocation .



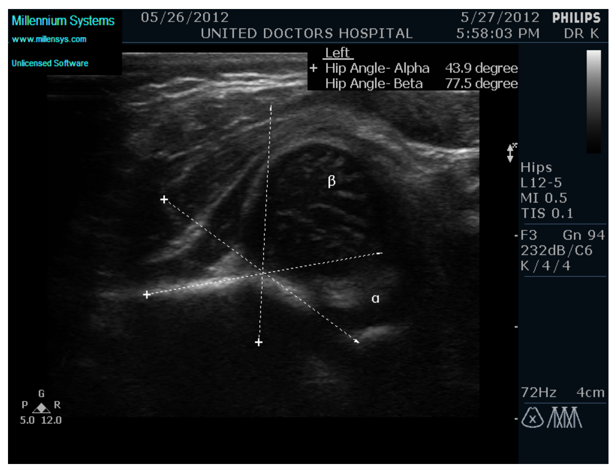
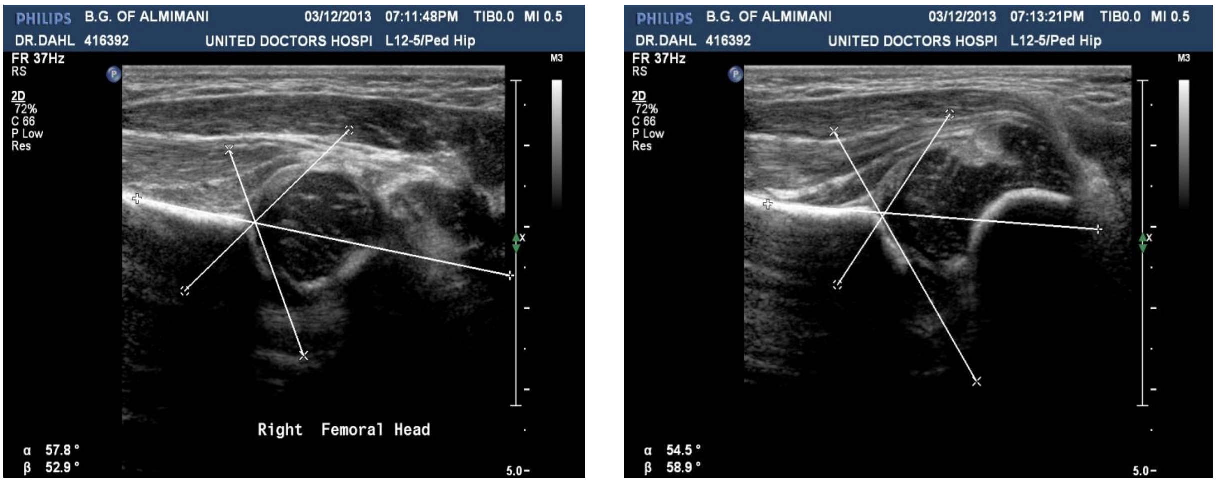


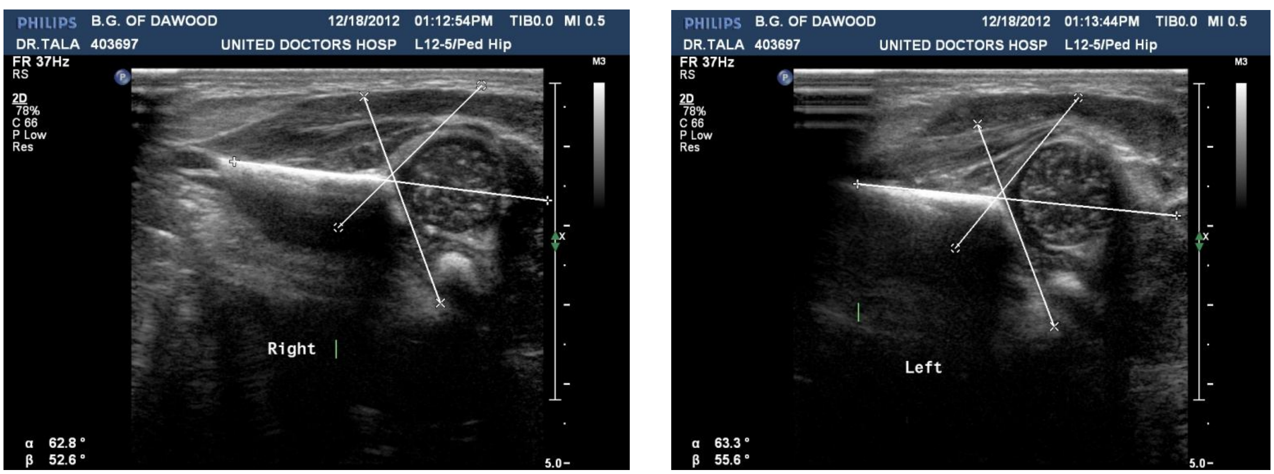
Image No (28).Coronal view, type 4, baby boy, 1 day,? right hip click , α 39.8, β 83.6, u/s finding show severe hip dislocation

Image No (29). Coronal view, type 4, baby boy, 1 day,? left hip click, α 43.9, β 77.5, u/s finding show severe hip dislocation

A B

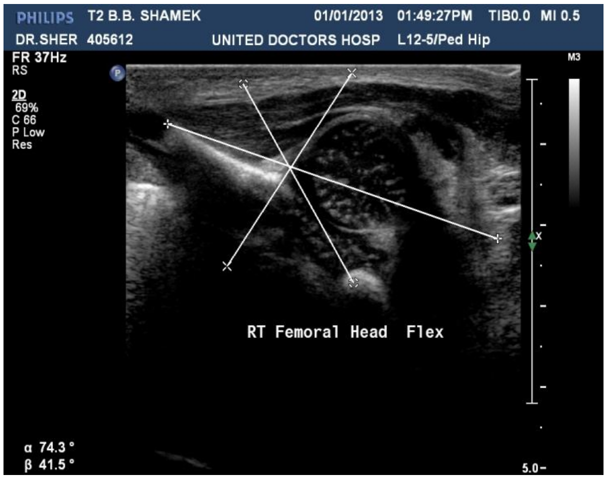
Image No (30) A, B shows Coronal view, type 2, baby girl, 30 days,? bilateral hip click, right α 57.8, β 52.9, left α 54.5, β 58.9 u/s finding show bilateral subluxed hip joint.



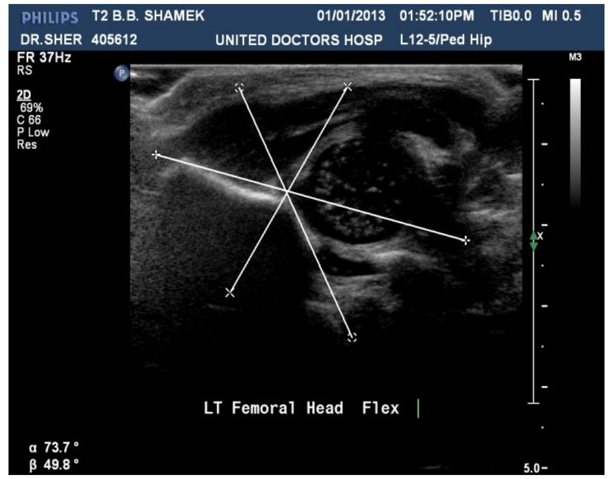


A B

Image No (31) A, B shows Coronal view, type 1, baby girl, 12 days,? bilateral hip click, right α 62.8, β 52.6, left α 63.3, β 55.6 u/s finding show bilateral subluxed hip joint.



A



B

Image No (32) A,B shows Coronal view, type 4, twins, 8 days, bilateral hip click, right α 74.3, β 41.5, left α 73.7, β 49.8 u/s finding show hip dislocation.