Chapter one

1.1 Introduction:

Fetal nuchal translucency (NT) was first introduced in 1992 as a potential ultrasound marker of fetal chromosomal defects in the first trimester. It measured the maximum thickness of subcutaneous translucency between the skin and the soft tissue overlying the cervical spine in a sagittal section of the ferns. A thickness of 3mm or more was found to be associated with a more than 10-fold increase in risk for chromosomal abnormality (Nicolaides et al. 1992).

Numerous studies have since been published to assess the application of fetal NT in the first trimester with maternal age in assessment of the risk of aneuploidy, in particular. trisomy21 (PandyeraL, 1995a; Szaboetal. 1995; TaipaleetaL. 1997; EconomidesetaL, 1998; Hafner et al.. 1998; Pajkrtetal., 1998; Snijders etal. 1998; The odoropoulous et aL, 1998; Schwarzleretal., 1999; BrizotetaL, 2001; Gasiorek-Wiens etalaL, 2001; Wayda et aZ 2001: Zoppi et al., 2001; Wald et al., 2003). In general, using a combination of maternal age and NT thickness in the first trimester for screening of fetal Down's syndrome, a detection rate of 69% at a false positive rate of 5% was reported (Wald et al., 2003).
A higher detection rate could be achieved when NT was combined with other biochemical markers. These include pregnancy associated plasma protein-A in the first trimester, n-human chorionic gonadotrophin, alpha fetoprotein, Unconjugated estriol and inhibin A in the second trimester (Wald et al., 2003).

NT thickness increases with gestational age (Pandya et al. 1995a; Braithwaite et al. 1996).

The position of fetal neck (Whitlow et al. 1998), Presence of nuchal cord (Schaefer et al., 1998) and size of ultrasound image (Herman et al., 1998 Edwards et al., 2003) have been reported to affect the thickness of NT. Adequate training and quality assurance are important to ensure the accuracy of measurement. A standard technique has been advocated to ensure the repeatability of NT measurement (Pandya, 1999).

Like other biochemical parameters, various biological variables have also been found to constitute a difference in the thickness of NT. The effects of ethnicity (Thilaganathan et al. 1998; Spencer et al. 2000a; Chen et al., 2002), fetal gender (Spencer et al. 2000b; Lam et al. 2001; Larsen et al., 2002), gravity and parity (Spencer et al., 2000c) on NT thickness have been studied. However, these alterations were not large enough to require adjustments in the screening programs which use NT as
one of the markers. It would be important to know if the thickness of NT in pregnancies conceived after assisted reproduction technology is different from those conceived spontaneously.

Figure (1.1); Shows represent three imaging modalities that identify early fetal development. The fetus on the left is an actual photo at 12 weeks. The fetus in the middle is from an MRI study and the fetus on the right is an ultrasound. The blue areas behind the neck represent the nuchal translucency that is measured during the first-trimester scan when evaluating the fetus for Down syndrome and other birth defects.

1.2 Problem of the study:

There is no references index in Sudanese population regarding to NT.

1.3 Objectives of the study:

1.3.1 General objectives:

- To Measure the nuchal translucency in normal fetus using ultrasound in order to find Sudanese index.
1.3.2 Specific objectives:

- To measure the nuchal translucency in first trimester of different gestational age.

- To measure crown rump length.

- To estimate gestational age using crown rump length and last menstrual period.

- To determine gravid and maternal age.

- To correlate between gestational and nuchal translucency measurement

- To correlate between nuchal translucency and crown rump length.

- To correlate between nuchal translucency and gravida.

- To find significant difference in nuchal translucency measurement in different parity group
1.4 Significance of the study:

This study will provide index of Sudanese nuchal translucency measurement as well as a relationship between nuchal translucency and gestational age and parity.

1.5 Overview of the study

This study will falls into five chapter, with chapter one is an introduction which include background about concerning the ultrasound and its application in NT measurement as well as problem of the study, objective and significance of study. While chapter tow which include literature review, it will present previous study that carried out by the scholar in the field of this study, Chapter three will present material used to collect the data and technique followed to accrue the collect data, chapter four include data presentation that illustrated in tables and figure. Finally chapter five will include discussion of the illustrated result, conclusion of the study and recommendation.
Chapter two

Literature Reviews

2.1 INTRODUCTION

Ultrasound or ultrasonography is a medical imaging technique that uses high frequency sound waves and their echoes.

The technique is similar to the echolocation used by bats, whales and dolphins, as well as SONAR used by submarine.

In ultrasound, the following events happen:

- The ultrasound machine transmits high-frequency (1 to 5 megahertz) sound pulses into your body using a probe.

  The sound waves travel into your body and hit a boundary between tissues (e.g. between fluid and soft tissue, soft tissue and bone).

Some of the sound waves get reflected back to the probe, while some travel on further until they reach another boundary and get reflected.

  The reflected waves are picked up by the probe and relayed to the machine.

The machine calculates the distance from the probe to the tissue or organ (boundaries) using the speed of sound in tissue (5,005 ft/s or 1,540 m/s) and the time of the each echo's return (usually on the order of millionths of a second).
The machine displays the distances and intensities of the echoes on the screen, forming a two-dimensional image like the one shown below (Pandya PP1995).

Figure 1-1 Ultrasound image of a growing fetus (approximately 12 weeks old) inside a mother's uterus. This is a side view of the baby, showing (right to left) the head, neck, torso and legs (Pandya PP1995).

A basic ultrasound machine has the following parts:

- transducer probe - probe that sends and receives the sound waves
-central processing unit - computer that does all of the calculations and contains the electrical power supplies for itself and the transducer probe

-transducer pulse controls - changes the amplitude, frequency and duration of the pulses emitted from the transducer probe

-display - displays the image from the ultrasound data processed by the CPU

-keyboard/cursor - inputs data and takes measurements from the display

-disk storage device (hard, floppy, CD) - stores the acquired images.

-printer - prints the image from the displayed data
ultrasound to obstetrics and gynecology has made tremendous impact to patient care as it allowed imaging of the fetus and placenta in obstetrics and maternal internal organs in gynecology with such clarity to allow advanced diagnosis and also to guide various life saving interventions. Understanding the physical principles of ultrasound is essential for a basic knowledge of instrument control and also for understanding safety and bioeffects of this technology.
2-1-1 PHYSICAL CHARACTERISTICS OF SOUND

Sound is a mechanical wave that travels in a medium in a longitudinal and straight-line fashion. When a sound travels through a medium, the molecules of that medium are alternately compressed (squeezed) and rarefied (stretched).

Sound cannot travel in a vacuum; it requires a medium for transmission, as the sound wave is a mechanical energy that is transmitted from one molecule to another. It is important to note that the molecules do not move as the sound wave passes through them, they oscillate back and forth, forming zones of compression and rarefaction in the medium (Pandya 1995).

First trimester ultrasound is often done to assess pregnancy location and thus it overlaps between an obstetric and gynecologic ultrasound examination. Accurate performance of an ultrasound examination in the first trimester is important given its ability to confirm an intrauterine gestation, assess viability and number of embryo(s) and accurately date a pregnancy, all of which are critical for the course of pregnancy (Pandya 1995).
2-1-2 TRANSVAGINAL ULTRASOUND EXAMINATION IN THE FIRST TRIMESTER

There is general consensus that, with rare exceptions, ultrasound examination in the first trimester of pregnancy should be performed transvaginally. The transvaginal transducers have higher resolution and are positioned closer to the uterus, the gestational sac and pelvic organs (Pandya 1995).

Main Objectives of Ultrasound Examination in the First Trimester
- Confirmation of pregnancy.
- Intrauterine localization of gestational sac.
- Confirmation of viability (cardiac activity in embryo/fetus).
- Detection of signs of early pregnancy failure.
- Single vs. Multiple pregnancy (define chorionicity in multiples).
- Assessment of gestational age (pregnancy dating)
- Assessment of normal embryo and gestational sac before 10 weeks.
- Assessment of basic anatomy after 11 week.

2-1-3 Indications for the Ultrasound Examination in the First Trimester:
- Amenorrhea (patient does not know she is pregnant)
- Pelvic pain.
- Vaginal bleeding.
- Unknown menstrual dates.
- Subjective feeling of pregnancy.
- Uterus greater or smaller than dates on clinical evaluation.
- Pregnancy test positive or increased Human Chorionic Gonadotropin (hCG) values.
- Nuchal translucency measurement.

**Embryo**

The embryo is first seen on transvaginal ultrasound as a focal thickening on top of the yolk sac giving the appearance of a “diamond engagement ring” at around the 5th menstrual week. First cardiac activity should be seen at 6 to 6.5 weeks. The embryo can be recognized by high resolution transvaginal ultrasound at the 2-3mm length size but cardiac activity can be consistently seen when the embryo reaches a -7mm in length or greater. Cardiac rhythm increases rapidly in early gestation being around 100-115 before 6 weeks, rising to 145-170 at 8 weeks and dropping down to a plateau of 137 to 144 after 9 weeks gestation.

The size of the embryo increases rapidly by approximately 1mm per day in length. The measurement of the length of the embryo, referred to as the Crown-Rump-Length (CRL), is reported in millimeters, Gestational
sac at 7 weeks gestation. The amniotic sac is seen as a thin reflective circular membrane. The yolk sac and vitelline duct are seen as extra-amniotic structures. It is the longest distance in a straight line from the cranial to the caudal end of the body and is the most accurate assessment for pregnancy dating.

Recent studies suggest that it is prudent to use a cut off of ≥7 mm (rather than ≥5 mm) for CRL with no cardiac activity for diagnosing failed pregnancy. This would yield a specificity and positive predictive value at (or as close as can be determined) to 100%. Since cardiac activity is usually visible as soon as an embryo is detectable, the finding of no heartbeat with a CRL <7 mm is suspicious, though not diagnostic, for failed pregnancy.

Note that the embryo develops within the amniotic cavity and is referred to as intra-amniotic whereas the yolk sac is outside of the amniotic cavity and is referred to as extra-amniotic.

The fluid that the yolk sac is embedded into is the extra embryonic coelom.

The appearance of the embryo on ultrasound changes from 6 weeks to 12 weeks gestation. At 6 weeks gestation, the embryo appears as a thin cylinder with no discernible body parts—the grain of rice appearance.
As gestational age advances, the embryo develops body curvature and clear delineation on ultrasound of a head, chest, abdomen and extremities “the gummy-bear appearance.

Close observation of anatomic details on transvaginal ultrasound at or beyond 12 weeks gestation may allow for the diagnosis of major fetal malformations.

2-2 Anatomy Nuchal Translucency:

The nuchal translucency (subcutaneous) is fluid found at the back of fetus head and neck, between the skin and soft tissue just beneath the skin posterior to the cervical spine has to be measured. The thickness of this fluid can be precisely measured and this is called the nuchal translucency (or NT) measurement. Normally the amount of fluid is small, producing a thin NT measurement. We know that the amount of fluid can increase in the presence of certain conditions, producing a thicker NT measurement. (Chudley and Chodirker, 2003)

1-10 week fetus. (Chudley and Chodirker, 2003)
2-11 weeks fetus. (Chudley and Chodirker, 2003)

3-12 weeks fetus

4-13 weeks fetus

Figure (2.1); (1-2-3-4) show Images of fetus during first trimester from 10 weeks to 14 weeks. (Chudley and Chodirker, 2003)
2.3 Pathophysiology:

2.3.1 Down’s Syndrome:

Down’s syndrome, a classic chromosomal disorder resulting in mental retardation and severe congenital disorders, was the first medical condition to be associated with a chromosomal abnormality. With the incidence rate of one in every 750 live births, early detection through screening is imperative to help in prenatal diagnosis of Down’s syndrome. This will provide the option of early termination of pregnancy and better obstetric care to the women with Down’s syndrome pregnancies (Gardner and Sutherland, 2004; Roper and Reeves, 2006).

The Down’s syndrome Screening Programme was started under the UK National Screening Committee (NSC). The UK NSC sets standards and oversees the implementation of screening programmes in England. The committee was set up in 1996. The recommended screening strategies from 2007 are the first trimester combined ultrasound and biochemical (CUB) screening, integrated testing and serum integrated testing. The Health Technology Assessment is currently reviewing two new strategies for screening, namely, repeated measure and cross trimester testing. These tests are expected to further improve the performance of Down’s syndrome
screening programmes in the period after 2010 (NHS Fetal Anomaly Screening Programme, 2008).

The earliest mention of this disorder was made by John Langdon Down in 1866. Down described this disorder as ‘Mongolian Idiocy’ in an essay classifying mental handicaps. However, the cause of the disorder remained unknown until 1959, when a French cytogeneticist, Jerome Lejeune, discovered trisomy 21 as the cause of this genetic abnormality. Subsequently, the condition was renamed as ‘Down’s Syndrome’ in 1961, after John Langdon Down (Chudley and Chodirker, 2003).

2.3.3 Maternal Age and Gestation:

The risk for many of the chromosomal defects increases with maternal age (Hecht and Hook, 1994). Additionally, because fetuses with chromosomal defects are more likely to die in utero than normal fetuses, the risk decreases with gestation. The rates of fetal death in trisomy 21 between 12 weeks (when NT screening is carried out) and term is 30% and between 16 weeks (when second trimester serum biochemistry screening is carried out) and term is 20% (Halliday et al., 1995; Snijders et al., 1995, 1999a; Morris et al., 1999).

With the development of prenatal screening, a need for maternal age-specific prevalence rates arose. A maternal age-specific rate schedule
developed by Cuckle et al (1987) is widely employed for the purpose. The maternal age-specific risk schedule was developed by plotting a regression curve using the combined results of eight large, published surveys of Down’s syndrome in live births. It was widely used in risk calculation and was embedded in many computer programmes used in routine screening. The widespread use of this rate schedule and the need for accurate maternal age-specific rates of Down’s syndrome, led to further critical re-evaluations of this data (Hecht and Hook, 1994).

Subsequently, Hecht and Hook (1996) reported that the schedule in their study predicted higher rates than those predicted by Cuckle et al (1987), particularly in older women and proposed an alternate rate schedule. This finding was confirmed by Bray et al (1998) using meta-analysis of nine data sets to estimate maternal age-specific risk. In 1998, Cuckle investigated the effect of using different maternal age-specific prevalence curves on detection rate, for three second trimester screening protocols. Cuckle (1998) concluded that the inaccuracy caused by the use of different maternal age curves is unlikely to markedly influence the Down’s syndrome screening result.

Pregnancies with Down’s syndrome are likely to end in spontaneous fetal loss. Therefore, the risk of having pregnancy with Down’s syndrome changes with gestational age. In 1999, Morris et al investigated the fetal
loss rates in Down’s syndrome pregnancies using data from National Down’s syndrome Cytogenetics Register. Based on this study together with two other previous studies (Macintosh et al., 1995; Halliday et al., 1995), Morris et al (1999) reported that nearly 43% of pregnancies ended in a miscarriage or still birth between the time of CVS and term, and about 23% of miscarriages or still births occurred between the time of amniocentesis and term and 12% of births were stillborn or resulted in a neonatal death. A later study by Savva et al (2006) on the relationship between maternal age and the risk of spontaneous fetal loss in Down’s syndrome pregnancies confirmed that the fetal loss rate in Down’s syndrome pregnancies increases with maternal age.

Figure (2.5). Shows NT MOMs in unaffected pregnancies and those with Trisomy 21 (Down’s syndrome). (Hecht and Hook, 1994).
Figure (2. 6). Shows hCG MOMs in unaffected pregnancies and those with Trisomy 21 (Down’s syndrome), (Hecht and Hook, 1994).

2.3.4 NT and other Chromosomal Defects:

In the Fetal Medicine Foundation Multicenter Project there were 325 cases with chromosomal abnormalities other than trisomy 21 (Snijders et al., 1998). In 71% of these, the fetal NT was above the 95th percentile of the normal range for CRL. Furthermore, in 78% of the pregnancies, the estimated risk for trisomy 21, based on maternal age and fetal NT, was more than 1 in 300. In addition to increased NT, there are other characteristic sonographic findings in these fetuses. In trisomy 18, there is early onset intrauterine growth Nuchal Translucency Screening Learn more about NT screening, an early, noninvasive option that can be exciting news for parents concerned about genetic disorders. Nuchal translucency screening, or NT screening, is an ultrasound test. It screens for Down’s syndrome (trisomy 21, meaning an extra copy of chromosome 21) and other disorders that are caused by extra copies of chromosomes (trisomy
13, trisomy 18), as well as congenital heart defects. Restriction (IUGR), relative bradycardia and, in about 30% of the cases, there is an associated exomphalos (Sherrod et al., 1997). Trisomy 13 is characterized by fetal tachycardia, observed in about two-thirds of the cases, early-onset IUGR, and holoprosencephaly or exomphalos in about 30% of the cases (Snijders et al., 1999b). Turner syndrome is characterized by fetal tachycardia, observed in about 50% of the cases, and early-onset IUGR (Sebire et al., 1998). In triploidy, there is early onset asymmetrical IUGR, relative bradycardia, holoprosencephaly, exomphalos or posterior fossa cyst in about 40% of cases, and molar changes in the placenta in about one-third of cases (Jauniaux et al., 1997).

Figure (2.7). Shows appearance of Trisomy 21 investigation (Jauniaux et al., 1997).
2.4 Diagnostic Methods:

2.4.1 Nuchal Translucency Screening:

Fetal nuchal translucency (NT) was first introduced in 1992 as a potential ultrasound marker of fetal chromosomal defects in the first trimester. It measured the maximum thickness of subcutaneous translucency between the skin and the soft tissue overlying the cervical spine in a sagittal section of the ferns. A thickness of 3mm or more was found to be associated with a more than 10-fold increase in risk for chromosomal abnormality (Nicolaides et al. 1992).

Numerous studies have since been published to assess the application of fetal NT in the first trimester with maternal age in assessment of the risk of aneuploidy, in particular. trisomy21 (PandyaeraL, 1995a; Szaboetal. 1995; TaipaleetaL. 1997; EconomidesetaL, 1998; Hafner et al.. 1998; Pajkrtetal., 1998; Snijders etal. 1998; Theodoropoulos et aL, 1998; Schwarzleretal., 1999; BrizotetaL, 2001; Gasiorek-Wiens etaL, 2001; WaydaetaZ 2001; Zoppi et al., 2001; Wald et al., 2003). In general, using a combination of maternal age and NT thickness in the first trimester for screening of fetal Down's syndrome, a detection rate of 69% at a false positive rate of 5% was reported (Wald et al., 2003). A higher detection rate could be achieved when NT was combined with other biochemical
markers. These include pregnancy associated plasma protein-A in the first trimester, n-human chorionic gonadotrophin, Alpha fetoprotein, Unconjugated estriol and inhibin A in the second trimester (Wald et al., 2003). NT thickness increases with gestational age (Pandya et al. 1995a; Braithwaite et al. 1996).

The position of fetal neck (Whitlow et al. 1998), Presence of nuchal cord (Schaefer et al. 1998) and size of ultrasound image (Herman et al. 1998 Edwards et al. 2003) have been reported to affect the thickness of NT. Adequate training and quality assurance are important to ensure the accuracy of measurement. A standard technique has been advocated to ensure the repeatability of NT measurement (Pandya, 1999).

Like other biochemical parameters, Various biological variables have also been found to constitute a difference in the thickness of NT. The effects of ethnicity (Thilaganathan et al., 1998; Spencer et al. 2000a; Chen et al., 2002), fetal gender (Spencer et al. 2000b; Lam et al. 2001; Larsen et al. 2002). Gravity and parity (Spencer et al. 2000c) on NT thickness have been studied. However, these alterations were not large enough to require adjustments in the screening programmes which use NT as one of the markers. The method of conception has been found to have a significant impact on the false positive rate in the screening of Down's syndrome. A significant elevation in the human chorionic gonadotrophin
level and a significant reduction in the alpha fetoprotein level in the maternal serum in the second trimester were found in pregnancies conceived after assisted reproduction. This resulted in a false positive rate much higher than expected (Barkai et al.. 1996; Heinonen et al., 1996; Ribbert et al., 1996; Frishman et al., 1997; Lam et al., 1999; Hui et al., 2003). With this observation, studies have proposed the use of maternal age and NT alone as the method of screening in these pregnancies (Maymon & Shulman, 2002).

It would be important to know if the thickness of NT in pregnancies conceived after assisted reproduction technology is different from those conceived spontaneously.

**Measurement technique:**

A strict mid sagittal section of the fetus in neutral position is essential in measurement of fetal NT. The image is magnified such that the fetus occupies as least 75% of the image. The head of the fetus should not be extended nor flexed. Care must be taken to distinguish between fetal sac and an-inion. The calipers are placed on the nuchal lines adjacent to the lucent area. The maximum thickness of the subcutaneous translucency between the skin and the soft tissue overlying the cervical spine is taken as the thickness of NT (Pandya, 1999).
Image size

A magnified image with the fetus occupying at least three-quarters of the image was recommended (Pandya et al. 1999) as the standardized technique in measuring NT. The effect of image size has been studied in two series. A study from Herman et al. (1998) showed that increased image magnification was associated with a statistically significant decrease in mean NT measurement, but the effect of image size was not considerable enough for a modification of caliper placement. The effect of image size was further confirmed by Edwards et al. (2003). In this series, a variation of up to 29% in the mean NT measurement was found when the image magnification changed from 60% to 200%. It is, therefore. Essential for screening centre to have an agreed standardization on image magnification for estimation of risk of Down's syndrome.

Caliper placement

As recommended by the Fetal Medicine Foundation on NT measurement, an on-to-On method with the calipers being placed on the nuchal lines just adjacent to the sonolucent area (Pandya, 1999) was advocated. The loss of repeatability of NT measurements could be largely accounted for by the placement of calipers (Pandya et al., 1995c). A study in Israel showed a significant difference of around 1 mm in NT measurement between onto-
on and on-to-out (outer caliper being placed outside the skin line) methods (Herman. Et al, 2000). Which might have a considerable effect on the calculated risk of aneuploidy. This further illustrates the importance of employing a standardized measurement technique.

Figure (2. 8). Shows standardized measurement Technique(Herman. Et al, 2000).

**Fetal neck position:**

The thickness of NT was reported to differ markedly with changes in the degree of fetal neck flexion (Nicolaides et al.. 1992; Whitlow et aL, 1998). In a study with 196 cases in United Kingdom, the mean NT measurement taken in the mid-sagittal, extended position was 0.62 mm greater than that taken in the neutral position. The mean flexed NT was 040 mm less than the mean neutral NT. Repeatability of the measurements was more accurate with the fetal neck in the neutral position with the
repeatability coefficients being 0.48, 1.04 and 0.70 in neutral. Extended and flexed positions respectively (Whitlow et al., 1998).

To help in capturing the best image in the mid-sagittal neutral position, a cine-loop Playback facility in the ultrasound machine would be useful.

**Fetal position**

In addition to the position of fetal neck, the position of fetus has been speculated to have an effect on the thickness of NT due to the influence of gravity. This issue has been evaluated in a study in Netherlands. Which examined the mean NT thickness in 85 women with the fetuses in prone and supine positions. The mean NT thickness was comparable in these two positions, being 1.91 mm in supine fetuses and 1.93 mm in prone fetuses (de Graaf et al., 2000). Hence, gravity seems to have no influence on NT thickness.

**Nuchal cord**

The umbilical cord may be mistaken as the NT when it is around the neck and the echogenic component of the cord is overlooked. The presence of nuchal cord diagnosed when complete encirclement of the fetal neck by the umbilical cord was visualized on color Doppler ultrasound. This was
found in 8.23% of the fetuses between 10 and 14 weeks of gestation. The presence of nuchal cord resulted in a mean of 0.8 mm being added to the ultrasound measurement of NT thickness. After the thickness of the cord was subtracted. The measurement of NT thickness did not different from those in the overall population in the study (Schaefer et al. 1998). The use of color Doppler was advised to check for the presence of nuchal cord for appropriate adjustment to be made.

2.4.2 Factors affecting nuchal translucency measurement:

2.4.2.1 Gestational age:

NT measurement was found to increase significantly with gestation (Pandya et al., 1995; Braithwaite et al., 1996; Hsu et al., 2003). It was positively correlated with crown rump length (Jou et al., 2001). Using a log-linear model, NT was reported to increase by around 1.7% per gestational week (Schuchter et al., 1998). Therefore the use of a single threshold NT thickness throughout the first trimester was inappropriate. A gestational age dependent Cut off point should be adopted (Fajkrt et al., 1995; Braithwaite et al., 1996). To adjust for the effect of gestational age.

The NT measurement could be expressed as multiples of Medians (MoM) for a given gestation. This was calculated by dividing the NT by the expected median NT in an unaffected population for that particular
gestational age. The median MoM in fetuses affected by Down’s syndrome was 1.96 (Wald et al. 2003).

2-5 previous studies:

Study done by Niemimaa M, Suonpää M, Perheentupa A, Seppälä M, Heinonen S, Laitinen said that, 1. Screening for Down syndrome in the first trimester by combining the measurement of fetal nuchal translucency and maternal serum β-hCG and PAPP-A is an efficient method, also among unselected low risk women. Those centers which have established the NT screening should consider adopting the combined approach.

2. In IVF pregnancies, β-hCG is elevated in the first trimester due to unknown reasons, increasing the false positive rate. Serum screening is not recommended in these pregnancies.

3. The first trimester ultrasound screening based on measurement of nuchal translucency seems to decrease less the live born incidence of Down’s children, compared with the second trimester maternal serum double screening, when the detection rate of the methods is similar. There is a concern that NT screening identifies preferentially those DS fetuses which are destined to miscarry.

-Nuchal Translucency in Normal Fetus and Its Variation With Increasing Crown Rump (screening for NT in normal fetus and correlate with CRL AND GA) done by Karki S, Joshi KS, Tamrakar
SR, Regmi S, and Khana conclude that NT measurement should be adjusted according to the gestational age for screening of chromosomal abnormalities. The fixed cut-off point through the first trimester is not appropriate and each NT measurement should be examined according to the gestational age. The current study offers normative data of the fetal NT thickness which can be used as reference for screening various chromosomal and congenital abnormalities.

-Nuchal Translucency in Normal Fetus and Its Variation With Increasing Crown Rump Length (Crl) and Gestational Age 2013;44(4):282-286. they conclude that the study offers normative data of NT thickness in normal fetus, which can be used as reference to screen various chromosomal and congenital abnormalities between 11-14 weeks of gestation. NT thickness increased with increasing CRL and a false positive rate increases with increasing gestational age.
Chapter three

Materials and Methods

3.1 Type of the Study:

This study is analytical study where result will be compared with international reference.

3.2 Area of the Study:

This data collected from pregnant female in first trimester with single fetus from different hospitals (BASHAIR HOSPITAL, ELSOUDI, other medical centers.

3.3 Duration of the Study:

The study was carried out over duration of 5 month from June 2015 to November 2015.

3.4 Sample:

The data were collected from 50 pregnant women with singleton pregnancies includes pregnant women aged from 19 years old and above to 35 years old, in Sudanese population,
● **Inclusion Criteria:**

Singleton Pregnant women attending routine antenatal clinics at 10–14 weeks of gestation.

● **Exclusion Criteria:**

fetus with down syndrome or any chromosomal abnormality.

### 3.5 Data Collection:

Data collection according to work sheet (Appendix) includes all above variables data.

### 3.6 Data Analysis:

Data analysis by using SPSS .16.using significant tests like T test, frequencies and regression .and also the correlation between variables and prevalence of NT, correlations between, age, CRL, GA.

### 3.7 Ethical Consideration:

The researcher will grant an ethical approval from the hospital and the ultrasound department as well as written consent from the patient. The collected data will be used for scientific research only and the ID of the patient or their personality will not be disclosed under any circumstances (Wald etal. 2003).
3.8 The NT Technique:

The Nuchal Translucency Scan is an ultrasound scan and is the first part of the Combined First Trimester Screening Test’. The second part is a specific blood test from the mother. All unborn babies have a collection of fluid found under the skin at the back of the baby’s neck. The thickness of this fluid layer is called the ‘Nuchal Translucency’ and is measured with ultrasound. Ultrasound imaging uses soundwaves to take pictures. It does not use radiation. Nuchal Translucency is measured because research has shown a link between the thickness of the fluid and an increased risk of common chromosomal abnormalities such as Down’s Syndrome. Factors such as the mothers’ age, weight, blood test results, and the nuchal translucency details, are combined to give you a result. This is a screening test and will not tell you if your baby definitely has an abnormality but may help in Decide if further testing is needed. (Wald etal. 2003).

3.8.1 Technique of doing NT Screening:-

Machine used:

All patients scanned by mendary, toshib,andEcube with high resolution.
Figure (3.2). Shows MENDARY Ultrasound System.
**Preparation before the Procedure:**

- A Nuchal Translucency scan is a painless procedure.

- No anesthetic is required.

- The medical imaging department will give you instructions on how to prepare for the scan.

**Preparations during the Procedure:**

- The lights in the room will be dimmed so that the pictures can be seen more clearly on the display screen.

- Pregnant women will lie in supine position and if difficult can take semi lateral decubitus position.

- Ultrasound gel will be put onto the pregnant abdomen. The gel allows the probe to slide easily over the skin and helps to produce clearer pictures.

- Ultrasound pictures are taken.

- Once the scan is complete, the gel will be wiped off pregnant skin.

- Depending on the procedure the ultrasound could take between 30 and 60 minutes. This time frame depends on the position and movement of the unborn baby.
**Technique**

- The gestational period must be 9 to 13 weeks and six days.
- The fetal crown-rump length should be between 45 and 84 mm.
- The magnification of the image should be such that the fetal head and thorax occupy the whole screen.
- A mid-sagittal view of the face should be obtained. This is defined by the presence of the echogenic tip of the nose and rectangular shape of the palate anteriorly, the translucent diencephalon in the Centre and the nuchal membrane posteriorly. Minor deviations from the exact midline plane would cause non-visualization of the tip of the nose and visibility of the zygomatic process of the maxilla.
- The fetus should be in a neutral position, with the head in line with the spine. When the fetal neck is hyperextended the measurement can be falsely increased and when the neck is flexed, the measurement can be falsely decreased.
- Care must be taken to distinguish between fetal skin and amnion.
- The widest part of translucency must always be measured.
- Measurements should be taken with the inner border of the horizontal line of the aliper 36 placed ON the line that defines the nuchal translucency thickness – the crossbar of the aliper should be such that it is
hardly visible as it merges with the white line of the border, not in the nuchal fluid.

- In magnifying the image (pre or post freeze zoom) it is important to turn the gain down. This avoids the mistake of placing the 37aliper on the fuzzy edge of the line which causes an underestimate of the nuchal measurement.

- During the scan more than one measurement must be taken and the maximum one that meets all the above criteria should be recorded in the database.

- The umbilical cord may be round the fetal neck in about 5% of cases and this finding may produce a falsely increased NT. In such cases, the measurements of NT above and below the cord are different and, in the calculation of risk, it is more appropriate to use the average of the two measurement. (Wald et al. 2003).

Figure 3-4 shows protocol for measurement of NT (Wald et al. 2003).
Chapter four

Results

The results of this study presented in tables and figures. The table show the frequency distribution of maternal age, gravid. the figures show the frequency percentage distribution and the relationship between NT and CRL, GA.

Table 4-1 frequency distribution table of maternal age

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Frequency</th>
<th>Percent</th>
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<tbody>
<tr>
<td>10-20</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>21-30</td>
<td>41</td>
<td>82.0</td>
</tr>
<tr>
<td>31-40</td>
<td>5</td>
<td>10.0</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>100.0</td>
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</table>

Figure 4-1 pie graph shows the percentage frequency distribution of maternal age
Table 4-2 frequency distribution table of parity

<table>
<thead>
<tr>
<th>Parity</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>1.00</td>
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</tr>
<tr>
<td>2.00</td>
<td>14</td>
</tr>
<tr>
<td>3.00</td>
<td>10</td>
</tr>
<tr>
<td>4.00</td>
<td>9</td>
</tr>
<tr>
<td>5.00</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

Figure 4-2 a bar plot shows the frequency distribution of parity for pregnant women.
Table 4-3 Mean±SD of NT and parity

<table>
<thead>
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<th>parity</th>
<th>NT± mean±SD</th>
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<tbody>
<tr>
<td>1.00</td>
<td>2.3±0.47</td>
</tr>
<tr>
<td>2.00</td>
<td>2.3±0.45</td>
</tr>
<tr>
<td>3.00</td>
<td>2.1±0.29</td>
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<td>2.4±0.35</td>
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<tr>
<td>5.00</td>
<td>2.6±0.15</td>
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</table>

Table 4-3 mean-SD of NT and liquor

<table>
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<tr>
<th>Liquor</th>
<th>Frequency</th>
<th>Meant±SD</th>
</tr>
</thead>
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<tr>
<td>NORMAL</td>
<td>48</td>
<td>2.3±0.6</td>
</tr>
<tr>
<td>DECREASE</td>
<td>2</td>
<td>2.1±0.4</td>
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</tbody>
</table>
Figure 4-3 a par graph show the distribution of liquor

![Graph showing distribution of liquor](image)

Figure 4-4 scatter plot of NT with CRL with trend line depicted a direct linear association

![Scatter plot of NT with CRL](image)

\[
y = 0.0133x + 1.632 \\
R^2 = 0.2389
\]
Figure 4-5 scatter plot of NT versus GA with CRL with trend line depicted a direct linear association.

Table 4-4 frequency distribution of NT

<table>
<thead>
<tr>
<th>GROUP</th>
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<td>1.4-1.6</td>
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<tr>
<td>1.7-1.9</td>
<td>5</td>
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<tr>
<td>2-2.3</td>
<td>9</td>
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<td>2.4-2.6</td>
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### Table 4-5 Frequency distribution table of CRL

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<td>71-78</td>
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### Table 4-6 Frequency distribution table of NT and CRL

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<th>CRL(mm)</th>
<th>NT(mm)</th>
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<th>1.7-1.9</th>
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</thead>
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<td>1</td>
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Figure 4-5 par graph show frequency distribution of NT and CRL

Table 4-7 frequency distribution of GA

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Table 4-8 Frequency distributions of NT and GA

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</table>

Figure 4-6 par graph show frequency NT and GA
Table 4-9 Mean±SD of NT and maternal race

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<th>Race</th>
<th>Frequency</th>
<th>mean NT±SD</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>east</td>
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<tr>
<td>west</td>
<td>6</td>
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<tr>
<td>south</td>
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<tr>
<td>Total</td>
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</table>
Chapter Five

Discussion, conclusion and recommendation

The main objective of this study is to measure nuchal translucency using ultra sound in order to find Sudanese index.

5-1 Discussion

The age of the maternal in this study range from 19-35 years old normally distributed with frequency of age groups in 21-30 which represent 82% with the mean age of 26.4±3.9 years (Table and Figure 4-1). Other study there range is from 17-44 and the mean age was 25 years.

The gravid range from 1 to 5 and the heist frequency represented by 2, also (table 4-3) show mean NT±SD when parity was two (2.3±0.45), and NT not affected by parity.

The liquor heist frequency represented as normal, and just two cases represent decreased liquor (Figur, Table 4-3), and there was no relation between abnormality in liquor and NT in this data.

Table The race of the maternal in this study show the heist frequency represented by east which represent 62%, and other race
show 38% (Table 4-5), this study show the mean NT for each race: for east the mean NT ± SD was (2.3 ± 0.15), WEST (2.2 ± 0.12), north (2.2 ± 0.12) and south (2.4 ± 0.12).

The mean CRL was 55.5 ± 16.8 mm (range 39-83 mm), mean NT thickness was 2.3 ± 0.4 mm (range 1.1-2.9 mm), respectively. The median gestational age was 12.9 weeks, previous study was shown that: the mean CRL was 63.6 range from 41-88 mm, and the mean NT was 1.55 mm range from (0.8-2.7) figure 4-5 show that that when CRL WAS 55-62 mm NT range between 2.4-2.6 mm in 8 fetus and represent high frequency, figure 4-6 show GA when range was (12-12.9 weeks, the NT 2.4-2.6 in 8 of data and just 7 with NT 2.4-2.6, this result to that : NT will be increase when GA increase.

The result of this study showed a significant correlation between NT and CRL therefore the NT increase by 0.48 mm for every 1 mm of CRL (Figure 4-4). In the same essence there is a significant correlation between the NT and GA perfectly, where the NT increase by 0.5 week/mm of NT (Figure 4-5).

This study found that the mean NT thickness in Sudanese population is 2-3 mm rather than other studies in Korean population found that mean NT thickness was 1.62, and Taiwanese population 1.7 mm.
5-2 Conclusion

This study was generally an attempt to measure the NT in normal fetus. Analytical study were collected from 50 pregnant women from August 2015 to October 2015 using trans abdominal scan through 3.5MHZ transducer.

The result shows that CRL can be used in linear equation to measure the NT as follows: \( NT = (0.0133 \times CRL) + 1.632 \). Similarly for GA as follows: \( NT = 0.2625 \times GA \times 0.8441 \).

Limitation of this study was that we cannot use transvaginal US because it is not available in hospitals.
5-3 Recommendation

- Pregnant women of age 19-45 years are advised to do U/S scanning routinely.

- The author recommends that the Government should introduce the modern ultrasound machines and increase the training institutes of ultrasound for increasing the sinologist skills and experiences.

- Further studies should be carried out in this field.
5-4 References:


4- Pandya PP, Kondylios A, Hilbert L, Snijders RJ, Nicolaides KH. Chromosomal defects and outcome in 1015 fetuses with increased nuchal translucency.


7- Snijders RJM, Johnson S, Sebire NJ, Noble PL, Nicolaides KH. First


20-Nicolaides KH, Brizot ML, Snijders RJM. Fetal nuchal translucency:


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34-Prenatal Screening Unit, Clinical Biochemistry Department, King George Hospital, Goodmayes, IG3 8YB, UK 2Harris Birthright Research Centre for Fetal Medicine, Kings College Hospital, London.
## Appendix A

### Master Data Sheet

<table>
<thead>
<tr>
<th>age</th>
<th>L.M.</th>
<th>GRAVI</th>
<th>C.R.L</th>
<th>GA</th>
<th>NT</th>
<th>LIQUR</th>
<th>RELATION</th>
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<td>206</td>
<td>4</td>
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<td>in</td>
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Appendix (B)

Ultrasound Images

Figure B-1: NT measurement (10 weeks)

Figure B-2 NT measurement in 12 weeks
Figure B-3: NT measurement

Figure B-4: NT measurement
B-5: NT measurement (11 Weeks Figure)

Figure B-6NT measurement
Figure B-7NT measurement

Figure B-8NT measurement
Figure B-9: NT measurement (10 weeks)

Figure B-10: NT measurement
Figure B-11: NT measurement

Figure B-12: NT measurement