INTRODUCTION

A caput succedaneum (CS) is the result of pressure on the fetal scalp by a dilating cervix during labor and is traditionally assessed in digital vaginal examination (DVE) as the presence or absence of a diffuse palpable scalp swelling. Typically, a CS is more likely to be present in prolonged labor, fetal macrosomia and where there is a narrow maternal pelvis with CS an indirect sign representative of potentially obstructed labor. There still remains a relatively high degree of inter-observer disagreement, however, amongst examiners of the fetal head position potentially leading to management errors [1]. Failure to progress during the second stage of labor may necessitate instrumental or operative intervention, increasing maternal and fetal morbidity and mortality [2]. Beyond these important short-term considerations, accurate assessment of the progress of labor as part of obstetric and midwifery good practice will impact longer-term maternal disability which includes pelvic floor damage and delayed presentations with pelvic organ prolapse and/or incontinence [3,4].

There has been recent interest in the ultrasonographic assessment of early labor as a predictor for the likelihood of successful vaginal delivery [5-8]. These data would suggest an advantage for intrapartum transabdominal ultrasound over DVE in the determination of fetal head position as an objective measure of the progress of labor [9, 10] along with value in the use of trans-perineal ultrasound (TPUS) to define the angle of progression of the fetal head, the head-perineum distance and the degree of CS [11, 12]. The measurement of the CS typically uses a sagittal ultrasonographic view of the fetal skull [13] although with this method Hassan et al. [14] have shown only a poor correlation between the clinical and ultrasonographic CS measurements during the first stage of labor. Data by Gilboa et al. [15] during the second stage of labor have shown no specific correlation between CS thickness and other parameters likely to affect the delivery mode including the fetal head position, the duration of the second stage or the head circumference. By contrast Hassan and colleagues reported a higher measurable CS in those women undergoing Caesarean delivery when compared with vaginal delivery using a CS cut-off of 10 mm [14]. A
systematic review reported by Verhoeven et al. [16] concluded that ultrasound assessment of the fetal position in early labor was of limited value in the prediction of Caesarean delivery with a greater benefit for decision making concerning operative vaginal delivery if the fetal head position was examined ultrasonographically later on during the second stage of labor. This current study evaluates CS measurement during the first stage of labor by TPUS as a predictor for the mode of delivery in singleton pregnancy.

**PATIENTS AND METHODS**

This prospective observational study was approved by the local hospital ethics committee with patients derived from the Division of the labor and delivery room at a 300-bed Community referral hospital. Women admitted to the ward in the first stage of labor were invited to participate in the study and those included provided informed written consent following an explanation of the research by a member of the clinical research group. Women were examined by DVE in the supine position with the clinical CS recorded as present or absent and an assessment of fetal head descent. In general, a DVE was performed prior to the ultrasound examination with birth attendants and parents blinded to the ultrasound measurements obtained. All ultrasound examinations were performed by a consultant obstetrician. The measurement of the CS was made following rupture of the membranes in singleton cephalic presentations after 37 weeks gestation (as estimated from a first trimester scan) and when cervical dilatation was deemed > 3 cm so as to allow direct contact of the US probe with the fetal head. Vaginal delivery was defined to include spontaneous and all assisted operative deliveries. Fetal head station was defined in accordance with the WHO categorization using the ischial spines as a reference point namely; 0-5 located at the pelvic inlet with + 5 located at the pelvic outlet [17].

The TPUS (LOGIC C3 Premium R2.03) was used to measure the angle of progression of the fetal head (AOP) so as to establish the fetal head station and to ensure that all CS measurements were made at station zero. The probe was gently rocked upwards in order to obtain a sagittal view of the long axis of the pubic symphysis and the leading portion of the fetal head. One line was drawn on the screen between calipers which identified the long axis of the symphysis and a second line was marked on the frozen image extending from the most inferior portion of the symphysis to the fetal skull contour.

The sagittal view provided the clearest identification of the CS which was recorded as the maximum distance between the outer border of the fetal skin and the outer border of the bone on the leading arc of the skull as previously described [14]. An image of this measurement is shown in Figure 1. Measurements were made with a portable 4-6MHZ convex transvaginal transducer using a Voluson i-system (GE Medical Systems, Zipf, Austria) with 3 CS measurements made in each case, recording the mean value of the CS measurements. Demographic data were collated for the patient cohort including the mode of delivery, the indications for operative delivery and a listing of any third stage complications.

Analysis of the data was performed with the SPSS Version 12.0 software package (Chicago, IL). Categorical variables were presented as means (and minimum/maximum) with comparisons made using the Fisher’s exact test and the Student’s t test. Odds ratios (+ 95% CI) were calculated for the Caesarean risk for both a millimeter increase in the CS measurement and for an increase in parity. For maximum sensitivity and specificity, a Youden’s index was used to calculate the optimal cut-off of CS measurement for construction of an ROC sensitivity/specificity curve. P values < 0.05 were considered significant.

**RESULTS**

Patients were accrued from the delivery room triage at the Maynei Ha Yeshua Hospital between December 2016 and February 2017 with 46 women recruited. The overall mean maternal age was 27.9 years (range 19-42 years) with an overall mean gestational age of 40.05 weeks (range 37.4-42.1 weeks). In the cohort, the average parity was 2.25 (range 0-9 deliveries) with 36 women delivered vaginally, 4 delivered using vacuum extraction and 5 delivered by Caesarean section. Three patients were excluded due to an AOP which exceeded 130 degrees. Women were divided into two main groups including those delivered vaginally, either operatively or spontaneously (Group 1) and those delivered by Caesarean section (Group 2). Table 1 shows the basic demographic data of the cohort along with the CS measurements. There was no statistical difference between the groups concerning either the AOP or the birth weight. The mean CS measurement overall was 10.29 mm (range 3.7-23.6mm). There were statistically significant differences in the mean CS measurements noted between the groups (9.56 mm in Group 1 vs. 15.84 mm in Group 2: 95% CI 2.008-10.552, P = 0.005). Further, there were significant differences between the groups in the average parturient age (Group 1 vs. Group 2 - 26.9 years vs. 35.6 years, respectively; 95% CI = 3.75-13.61; P = 0.001), the mean gravidity (Group 1 vs. Group 2 - 3.29 vs. 3.88, respectively; 95% CI = 2.144-8.078: P = 0.001) and the mean parity (Group 1 vs. Group 2 - 1.89 vs. 5, respectively; 95% CI = 0.679-5.532: P = 0.013).

For each millimeter increase in the measured CS there was a 39% increase in the risk for Caesarean delivery (95% CI 1.047-1.846; P = 0.023) with a 68% increase in Caesarean risk for each increase in parity (1.081-2.613; P =0.021). Figure 2 shows the ROC curve for Caesarean delivery at a CS measurement >13.75 mm (at station <1)resulting in a sensitivity of 80% and an 87% specificity. The ROC curve was based on the univariate analysis of significant results i.e. parturient age, gestational age and gravidity

<table>
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<tr>
<th>Vaginal Delivery</th>
<th>Caesarean Delivery</th>
<th>Mean</th>
<th>Min.</th>
<th>Max.</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs.)</td>
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<tr>
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<td>8.4</td>
<td>3.88</td>
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<td>37.4</td>
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<tr>
<td>CS (mm.)</td>
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<td>23.6</td>
</tr>
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<td>Birth Weight (gm)</td>
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<td>3388</td>
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</tr>
</tbody>
</table>

Legend: CS = Caput succedaneum, AOP = Angle of progression
Levy G, Zines Y and Olteanu I, Measurement of Intrapartum Caput Succedaneum as A Predictor of Delivery Mode

DISCUSSION

This study would suggest that CS measurements assessed by ultrasound, made in singleton pregnancy during labor with the cephalic presentation at station 0 (before the fetal head enters the true pelvis) are predictive of the mode of delivery. There is a significantly lesser CS in those who were ultimately delivered vaginally when compared with the Caesarean delivery group, along with a moderately high sensitivity and specificity of a 13.75 mm CS cut-off for predicting the risk of a Caesarean delivery. For each millimeter increase in the measured CS there was a corresponding 39% increase in Caesarean risk and for each increase in parity the Caesarean risk increased by 68%.

Digital vaginal examination (DVE) is the main method for determining the diagnosis of arrest of labor and its progress although it is intrusive and inconsistent between examiners. Transperineal sonography (TPUS) can be used during labor as a simple, non-invasive and objectively reproducible method that can determine not only the CS but also the angle of progression of the fetal head [12, 18] and the distance in advanced labor between the head and the perineum [11, 19]. Current evidence suggests that ultrasound is the preferred method for detection of the fetal head position with a greater accuracy than DVE [9, 20, 21] although comparisons of ultrasonographic data assessing fetal head characteristics and position will be affected by differences between the studies in the timing of the examinations. Early imaging in labor will tend to result in a high rate of diagnosis of the OP position, however, spontaneous rotation potentially limits the clinical value of such an examination. By contrast, later imaging will more likely influence decision making concerning operative vaginal delivery [6].

Our findings differ with those of Gilboa et al. [15] where the ultrasonographically measured CS did not correlate with the mode of delivery. Their study, however, measured the CS in women during prolonged second stage labor where it has been suggested that the degree of the CS when measured at this time may relate more to the duration of labor than to the delivery mode [22]. Hassan et al. [14] measuring the CS using TPUS in the first stage of labor showed that there was a high interobserver repeatability with the method and similarly to our study (although using a smaller CS cut-off) demonstrated a higher measurable CS in those women undergoing Caesarean delivery when compared with the vaginal delivery group.

Nowadays, given the rising level of Caesarean delivery [23] a reliable method in the early stage of labor that will predict Caesarean likelihood would have substantial benefit in allocating resources and staff in obstetric care as well as in informing patient expectations [24]. The use of a marker like the CS thickness should ideally be independent of parity, cervical favorability or the indication for induction of labor. Our population reflects a predominantly Orthodox Jewish group of women where gravidity and parity are high, both significantly influencing the Caesarean rate. It is therefore accepted that our data concerning CS measurement as a predictor of Caesarean delivery may not be applicable in other populations with lower average parity. Our Caesarean patients are also older than those delivered vaginally; a finding in keeping with other data correlating the rate of Caesarean section with maternal age [25]. Although the study is prospective and the obstetricians in the delivery room were blinded to the CS measurements, there are several other limitations to our study. The numbers of patients are small. It is also appreciated that patient management was provided by a mixed group of care providers with a variability in their rates of Caesarean delivery. Unselected populations which include those with prolonged and normal labor will likely affect the clinical focus on CS cases and potentially bias towards Caesarean delivery. The inclusion of those patients with a prior Caesarean delivery will also bias the results since these women will have a lower rate of induction of labor where the decision for Caesarean delivery will reflect more the factors specific to the prior operative approach. Comparisons may also be limited when there is an inclusion of cases with a higher risk for Caesarean delivery such as those nullipara with OP presentations and a prolonged second stage of labor.

Our study is not powered, and a future powered study based upon our initial results and designed to specifically investigate the association between ultrasound-measured CS and delivery mode needs to be conducted. There will be other potential immediate and longer-term advantages with a validated predictor for Caesarean delivery. A reliable mechanism of assessment of the likelihood of arrested labor will influence maternal and neonatal risk along with the need for episiotomy.
extension, the risk of perineal tears and later on the long-term sequelae resultant from damage to the pelvic floor and perineal soft tissues. It is appreciated that intrapartum sonographic assessment of the fetal head and its characteristics will be insufficient to uniformly predict labor outcome where parity, birth weight, the type and size of the maternal pelvis, the quality of uterine contractions and the threshold for induction of labor will control the vaginal-Caesarean rates in each environment. Over-reliance also on any specific predictive test can potentially influence staff in the delivery room on whether or not to await a spontaneous birth and could if conveyed to the mother possibly demotivate her towards vaginal delivery. In summary, our study which measures the CS with TPUS at 0 station is predictive of the mode of vaginal delivery. In summary, our study which measures the CS thickness and the delivery, showing a linear relationship between the CS and TPUS at 0 station is predictive of the mode of vaginal delivery. In summary, our study which measures the CS thickness and the delivery, showing a linear relationship between the CS thickness and the Caesarean risk. Future analysis of the predictive value for delivery outcome of the CS measurement in a larger cohort of patients in early labor is justified.

References


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