



Feasibility study for the value of pelvic floor distension in predicting mode of birth for women undergoing Vaginal Birth After Caesarean

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ABSTRACT

Introduction & hypothesis: Women having Vaginal Birth (VB) have different soft tissue dynamics to women requiring emergency Lower Section Caesarean Section (LSCS).

Aims: To assess the role of ultrasound in the assessment of LH distensibility in predicting outcomes for women wishing for Vaginal Birth After Caesarean section (VBAC). To inform subsequent trial design including understanding women's attitudes to the use of ultrasound in prediction of vaginal birth

Methods: Nulliparous, previous VB and previous LSCS underwent a transvaginal ultrasound. This scan looked at the distensibility of the LH and then correlated with mode of birth. Analysis used logistic regression and ROC curves analysis for static measurements and distensibility. A second cohort was also asked about their views as to the usefulness of such a tool to help inform on the utility of such a model.

Results: The original hypothesis confirmed maternal BMI, Anterior Posterior (AP) diameter at rest and AP distensibility all being significant predictors of VB in nulliparous women. As expected this relationship was also seen in women who had previously had a vaginal birth. Of the VBAC group, 23 women had LSCS. Five were Robson category, 18 had emergency LSCS in labour. 25 women had VB. Whilst there were trends towards lesser distensibility in VBAC women who delivered vaginally, none of these reached significance. The concept of the use of scanning to inform women as to likelihood of successful vaginal birth was supported by the survey.

Conclusion: Previously noted characteristics in nulliparous women for pelvic floor distension were confirmed. This relationship was not demonstrated for the VBAC cohort. We were unable to establish criteria for a simple ultrasound model to predict VB in women wishing for VBAC. Overall, women would welcome such model if it were available.

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Introduction

The three key components of labour are 'Power', 'Passage' and 'Passenger'. Historically, pelvimetry assessed the 'Passage' as a predictor for delivery [1]. Tooze-Hobson in his MD thesis demonstrated differences in the physical characteristics of the pelvic floor muscles between nulliparous women who delivered vaginally compared to those by emergency caesarean section, leading to the hypothesis that soft tissue characteristics are an important component in ability to deliver [2,3]. We wanted to look at women undergoing VBAC who represent a higher risk group for a labour and where particularly induction of labour where scar rupture and

hypoxic birth injury are small but significant risks [4] and the ability to predict Vaginal Birth (VB) may be extremely useful.

Our aim was to confirm the previous observations of nulliparous women and test whether this could be extrapolated to primiparous women who had had a previous LSCS as a predictor of mode of birth. The study was designed to inform on recruitment and patient views in their decision making and as such women's views were sought as to whether developing a prediction model would have any utility with patients.

Methods

Women were recruited prospectively. Recruitment was in 2 cohorts, the first during 2014–2015 and the second in order to complete the sample recruited over a further 2-year period (2017–19).

Inclusion criteria were women with a singleton pregnancy, as there is no data examining pelvic floor biomechanics in twin

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Table 1
Delivery Outcome of women.

Group	Number	Missing data	Elective LSCS (cat 3–4)	Emergency LSCS (cat 1–2)	Spontaneous VB	Assisted VB
Nulliparous (Control group 1)	99	1 (1 %)	2 (2 %)	22 (22 %)	40 (40 %)	34 (34 %)
previous spontaneous VB (Control group 2)	58	0	1 (2 %)	4 (7 %)	46 (79 %)	7 (12 %)
VBAC	49	1 (2 %)	5 (10 %)	18 (37 %)	15 (31 %)	10 (20 %)

pregnancies. We excluded women with any pre-existing conditions which might influence delivery mode. Recruitment was at any stage of pregnancy.

Participants were categorised into three groups:

- 1 Women with one previous caesarean and planning a VBAC.
- 2 Women who are in their first ongoing pregnancy (control 1).
- 3 Women having had one previous VB (control 2).

Since the trial group has never previously been tested before there are no data to inform on the numbers required to test this hypothesis.

Recruits underwent a transvaginal scan in the third trimester using the BK Medical Flex Focus 1202 ultrasound scan machine with a frequency between 6–16 MHz. All scans used a rectal probe using both three and two-dimensional modes

The scans were undertaken by AO and EE both with training and supervision from PTH. Measurements were made of the LH in the longitudinal plane and 3 widths (anterior, mid and posterior) as well as LH area, measurements were taken at rest and at valsalva. Three images were captured for each assessment to allow for

artifact and ensure adequate image quality. The images were anonymised. Images were reviewed by PTH and the best image used for measurement. Analysis was blind to the mode of delivery. Review of scans was performed in blocks commonly prior to delivery, removing any bias.

The distensibility was calculated as valsalva measurement minus the rest measurement/rest measurement $\times 100$ [3,4]. Statistical analysis (GraphPad Software, Inc.) included descriptive statistics, ANOVA comparison between groups, and simple logistic regression [5]. ROC curves were calculated in the different groups. Logistic regression was performed to determine what may be helpful in any subsequent model.

Women's views as to the utility of such a service were sought to help inform any further grant application. The questionnaire was non validated and merely used to record views and opinions about VBAC using a more qualitative approach. The questions used an analog scale 1–10 to rank how strong their feelings were, and there was space to explain their choice. (diagram 1)

Ethics was obtained: PLUSS MODEL (ref 14/LO/1718) and PLUSS OASIS (ref:18/EM/0151).

Table 2
Baseline characteristics of recruits.

Study Mode of delivery	P0 VD	P0 LSCS	P1 VD	P1 LSCS	VBAC VD	VBAC LSCS
Age (mean, range)	30 (19–44)	31 (21–41)	32 (19–42)	34 (31–37)	31 (19–40)	32 (23–43)
BMI (mean, range)	27 (19–48)	31 (21–47)	26 (18–43)	27 (23–36)	28 (18–48)	29 (19–37)
ethnicity	59 –	15 –	44	3	17	10
Caucasian other	15 –	6	9	2 –	8	8
Mean LH area at rest (cm ²)	13.22	13.85	14.09	12.64	13.55	13.77
Mean LH area at Valsalva (cm ²)	14.26	14.5	15.33	13.28	14.65	14.71
Mean distensibility of LH area (%)	9.41	9.86	11.01	5.89	7.94	7.79
Mean LH AP at rest (cm ²)	51.66	54.82	51.72	52.18	13.55	13.77
Mean LH AP at Valsalva (cm ²)	52.36	54.31	54.24	49.74	14.65	14.71
Mean distensibility of LH AP (%)	1.54	–1.6	5.12	–4.28	4.77	8.33
Mean LH area at rest (cm ²)	32.96	33.64	35.12	33.9	34.23	34.29
Mean LH area at Valsalva (cm ²)	35.23	34.1	36.06	34.56	35.14	32.73
Mean distensibility of LH area (%)	7.38	1.6	3.08	1.89	1.02	3.27
Fetal weight [kg] (mean, range)	3.4 (1.6–6.7)	3.6 (2.8–4.6)	3.3 (2.1–4.3)	3.3 (2.4–3.9)	3.2 (2.1–4.1)	3.6 (2.4–4.6)
Fetal head circumference [cm] (mean, range)	34 (29–38)	35 (31–39)	34 (31–37)	34 (30–37)	34 (31–37)	35 (32–38)

Table 3
Other characteristics for predicting VBAC.

Variables	OR (95 % CI)	p-value	ROC – AUC	p-value	St. error
Maternal age	0.9 (0.86–1.07)	0.5	0.5	0.6	0.08
Maternal BMI	0.9 (0.87–1.08)	0.6	0.5	0.4	0.09
Ethnicity	0.58 (0.16–2.06)	0.4	0.5	0.4	0.08
LH distensibility	0.9 (0.95–1.04)	0.4	0.5	0.8	0.08
AP distensibility	1 (0.9–1.04)	0.8	0.5	0.4	0.09
Tr distensibility	0.9 (0.89–1.03)	0.2	0.6	0.2	0.09
LH rest	0.9 (0.7–1.2)	0.8	0.5	0.8	0.09
AP rest	0.9 (0.8–1.08)	0.7	0.5	0.9	0.09
Tr rest	1 (0.8–1.2)	0.9	0.6	0.2	0.09
LH Valsalva	0.9 (0.8–1.17)	0.7	0.5	0.6	0.09
AP Valsalva	0.9 (0.8–1.06)	0.5	0.5	0.4	0.09
Tr Valsalva	1.02 (0.8–1.19)	0.7	0.5	0.3	0.08
Fetal weight	0.2 (0.07–0.8)	0.04	0.67	0.05	0.08
Fetal head circumference.	0.85 (0.58–1.23)	0.4	0.5	0.5	0.09

LH area distensibility P0: VD vs all LSCS

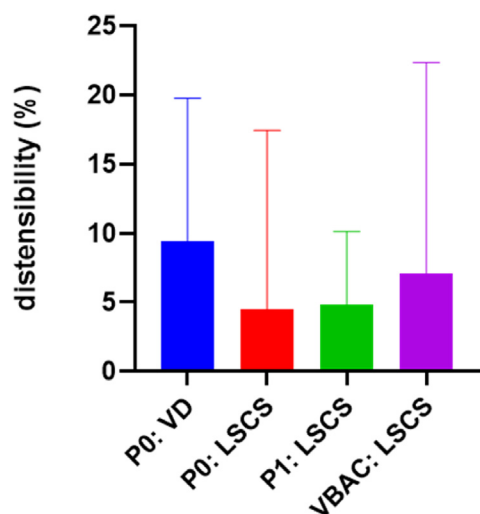


Fig. 1. Levator hiatus area distensibility in nulliparous women.

Results

Two hundred and six women were recruited to the study (Table 1) 2 were excluded for missing data (1 in nulliparous group and 1 in VBAC). Data relating to indications for first LSCS in VBAC group were not collected. Table 2 shows the demographics of the women in the study and Table 2 shows details of the deliveries.

Control groups

The original findings from Tooze-Hobson in his thesis [2] demonstrating a difference in the characteristics of how the pelvic floor functions in nulliparous who gave birth vaginally and those who required emergency LSCS were confirmed a new observation confirming this in primiparous women found (Table 3). Maternal BMI 19 was associated with 90 % probability of vaginal delivery AUC 0.68 $p = 0.01$ in the primiparous cohort (control group 2). With, again, the observation that there was greater distensibility in the group delivering vaginally compared with any of the women from any group who delivered by LSCS (Fig. 1).

ROC curve LH area: P0 VD vs VBAC LSCS

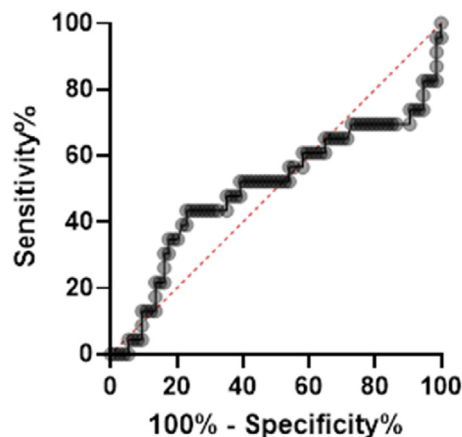


Fig. 3. ROC for levator hiatus distensibility as predictor for mode of delivery VBAC AUC 0.5.

There was lesser distensibility in all groups delivered by emergency LSCS when compared to control group 1 (P0-VD). ANOVA 0.2

There was less distensibility in LSCS for Control group 1 (P0) and Control group 2 (P1) but not the VBAC group. ANOVA $p = 0.02$

VBAC group analysis

Despite the overwhelming desire of women to achieve a VB, 50 % were delivered by LSCS. Five (10 %) of these had elective (cat 3–4) LSCS and 18 (37 %) emergency (cat 1–2 (Table 2).

Unfortunately, the association seen in the control groups to predict mode of delivery was lost in women who had had a previous LSCS. (Figs. 2 and 3)

Similar ROC curves were generated for linear measurements of AP diameter and the transverse measurements. Logistic regression for all static and dynamic levator ani dimensions as well other variables i.e. BMI, age, fetal weight and head circumference in relation to mode of delivery outcome was also undertaken (Table 4) which demonstrate that the original hypothesis does not hold true for women who have had a previous term pregnancy resulting in a Caesarean section.

Factors associated with a successful VBAC were maternal BMI, distensibility in AP diameter and at rest, and fetal weight. Logistic

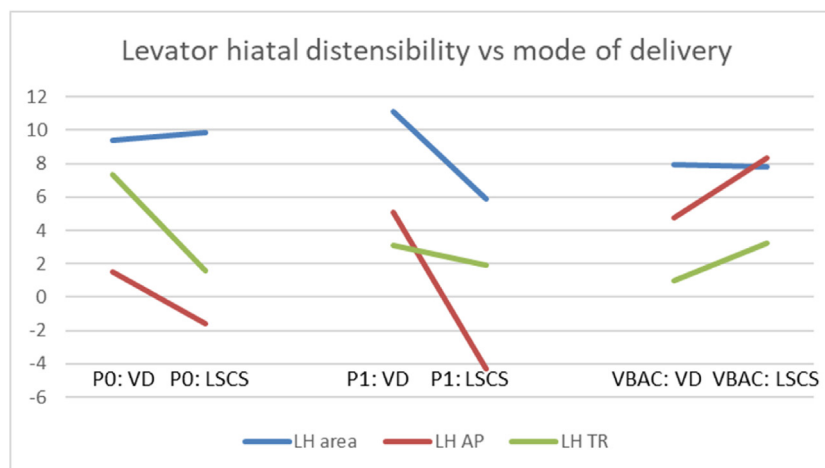


Fig. 2. Differences between three groups (P0, P1, VBAC) by subsequent delivery method.

Table 4

Womens views of importance of vaginal birth or Caesarean section.

Question	unimportant	undecided	significant	Maximum 10/10
How important is aiming for a normal birth to you?	3 (5 %)	15 (26 %)	16 (28 %)	24 (34 %)
how important was it to avoid a LSCS	4 (7 %)	19(29 %)	20 (34 %)	17 (29 %)

regression showed that fetal weight 2.1–2.4 kg was associated with likelihood of a successful VBAC 82–87 %. ROC AUC 0.67 $p = 0.05$. (Fig. 10).

Questionnaire results

58 women completed the questionnaire. 23 (40 %) had an absolute desire to give birth vaginally (score 1), with a further 9 (16 %) having a preference for a vaginal birth (score 2–3); 18 (31 %) were neutral in their opinion (scores 4–7), 4 (7 %) had a preference towards LSCS (score 7–8) with 4 (7 %) an absolute wish to be delivered by LSCS (score 10). Overall 56 % actively wanted a VB and 14 % actively wanted a LSCS.

Four salient points were identified considering preferred mode of birth within the free text of 'A focus on birth choices', 'Informed decision making', 'Safety considerations' and 'Locus of control'. These are important to identify as psycho-social aspects of birth and do not always align with medical imperatives but impact on birth outcomes [6].

Women predominantly desired VB. Even when they indicated that they would choose a caesarian for other reasons, vaginal birth remained the desired and optimal option 'I'm really looking forward to a vaginal delivery as opposed to a c section', which was echoed when considering recovery after birth.

The test's potential value as means of informing decisions around birth options aligned to the dominant preference for VB. Several women expressed that it could help to reduce or avoid disappointment by managing expectations 'it would create less stress during the birth itself if you knew the likelihood of a vaginal birth'.

Safety considerations were the predominant influencer on birth choices with some women who wanted a VB choosing a LSCS 'I want a vaginal birth but I fear the complications, so for safety I'm more towards caesarean'. There was also a differentiation between elective LSCS and emergency LSCS, with several women highlighting that avoiding an emergency LSCS was more important than having a VB, 'I want a vaginal birth but I fear the complications, so for safety I'm more towards caesarean'. Birth safety was the primary consideration for having the pelvic floor scan, with only one woman voicing reservations about having the test 'Not sure about the efficiency/side effects of the scan'.

The majority of women indicated that the scan would help inform and give them additional agency in their decisions. One woman was clear that this was not something that she would welcome, preferring a rather external locus of control ('I'll do') . . . *Whatever the doctor says*'. Whilst this may not be the view of most women it is the case that pregnancy and birth are often fearful times for women 'I want a vaginal birth but I'm scared I won't be able to' and that handing that control over to health professionals is a valid way of coping.

When asked about influence on decision making and choice, 3 (5 %) said none (all of which had a strong preference for VB), 13 (22 %) were unsure as to whether it would help and 42 (72 %) said it would be useful. When asked as to whether the scan would influence their decision, 3 (5 %) women said no and again all 3 were set on a VB. Of the remaining 53, 30(52 %) were undecided (score

4–7) and 22 (38 %) would potentially be highly influenced (scoring 8–10), with 12 (21 %) scoring it the maximum 10 for influence.

When asked about influence of individualized results and decision for birth, 5 responded none, 5 were undecided with the majority of 47 responded it would.

Of the women planning to attempt VB there was considerable interest in the place of such a tool, if available. As such the tool would be useful in decision making if valid and available.

Themes from the questionnaire

Overall the questionnaire confirmed a strong desire to give birth vaginally and the scan was seen by the majority as a potentially good thing, principally at reducing risks and stress "It would create less stress during the birth itself if you knew the likelihood of vaginal birth". As such, in this sample the objective of trying to make childbirth easier and reduce risk was understood and supported with comments such as "(it would be) Helpful and empowering in decision making" and "I would like to be as informed as possible before, making my choice- and what will be safest for baby and me".

Despite the desire to have a VB it was interesting that there was also an importance attached by many women towards LSCS and safety for the birth.

Discussion and conclusion

Our results show that a test to predicting VB, would inform choice. Our data confirm the original hypothesis in our control groups of different soft tissue dynamics in nulliparous women and a new observation in women parous women with a previous vaginal birth.

Unfortunately, these characteristics appear to be lost in women who have had a LSCS.

There are a number of reasons why this may be the case: Firstly, and probably most importantly, the indication for previous LSCS was varied, meaning that the VBAC group were highly heterogeneous. Some of these women would have had elective LCSC and therefore their pelvises were "untested" in obstetrics, in others it was difficulties in the original labour. Distensibility is a variable muscular pelvic floor activity dependent on individual circumstances, which may also have changed as a result of the original trial of labour, leading potentially to elements of denervation with subsequent muscle fibre loss. Age may also be a factor as women having a second baby are on balance likely to be older.

These observations have been born out in a recent MRI based study on pelvic muscles changes in pregnancy. Only some parous women were able to regain their pelvic floor muscles shape similar to their nulliparous counterparts after delivery, which supports the hypothesis of pregnancy related soft tissue remodeling and /or intrapartum injury [7].

Further work probably requires segregation of the VBAC women into more specific groups from their initial LSCS, such as fetal distress, failure to progress and elective LSCS to investigate utility of this measurement further. Attempting at this work may require a significantly more sophisticated model to be developed and would require a significantly larger study.

Author statement

P Toozs-Hobson: concept, design, data collection, interpretation, manuscript preparation

E Edwards: performing scans, data collection, manuscript preparation

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J Benjamin Toozs-Hobson Manuscript preparation

Declaration of Competing Interest

Financial disclaimer PTH has acted as a consultant to Contura and Boston Scientific

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