THE PURPLE LINE AS A MEASURE OF LABOUR
PROGRESS: A LONGITUDINAL STUDY

I was delighted to be asked to review this study because, as the authors point out, the purple line has long been proposed as a possible means of non-invasive monitoring of progress in labour.

The paper reads well and the team cite two statistical advisors. I would suggest no major compulsory revisions, only minor discretionary revisions which I will mention within the body of this review.

Background

In background paragraph 5, the authors cite NICE [21] recommending four hourly VEs and then Cheyne et al [24] who found an average length of labour of eight hours with three VEs. This ratio would seem entirely consistent with VEs at onset, four hours later and again at eight hours. The use of the word ‘however’ therefore seems inappropriate.

The use of quotation marks around ‘offered’ in regard to the NICE guidelines would indicate the authors share my own reservation about the status of this ‘offer’ (I have reservations about the evidence base of this recommendation and even more in relation to the power of the social context in which such ‘choices’ are given and such ‘decisions’ are made, and by whom). Discussion of this nuance would be useful but I think the authors are right to avoid it in their paper and perhaps so should I in this review.

In background paragraph 9 an ‘objective’ measurement is mentioned, when paragraphs 1 and 2 have blown that notion out of the water. While a woman may well want to know how she is progressing in labour, surely an inter-subjective measure is perfectly reasonable, with the woman and midwife together coming to an understanding of progress (or otherwise) from their own subjective readings of the birthing process.

In the same paragraph, alternatives or adjuncts to VE must only be ‘at least as’ reliable as VE.

Later in background paragraph 9, vasocongestion at the sacrum due to intrapelvic pressure is proposed as a possible causation of the purple line
phenomenon. It occurred to me that possibly changes in the shape of the pelvis, natural changes in the pelvic diameters, or distortions normal to dynamic labour and increased pelvic mobility in late pregnancy, might also be proposed. I am thinking of the phenomenon of the rhombus of Michaelis which has also been described in advanced labour, which also might be indicative of pelvic changes expressed externally. In my experience of practising midwifery in Malawi, I recall women there speaking of their ‘back breaking’ or their ‘back opening-up’ in late labour. These local and apocryphal coinages might well be foundations for an alternative explanation of the purple line phenomenon.

Methods

That a power calculation was considered is reassuring, but to a non statistician (such as myself) the second paragraph would benefit from some expansion and clarification. For example, one hopes to detect a 10% difference in what? It would seem that Byrne and Edmonds demonstrated that 10% of the population did not show a purple line. The authors here would seem to want to demonstrate something rather more sophisticated, that is, a relationship between the length of the line (where it appears) and other indicators of labour progress. It would seem therefore that a more rigorous statistical power calculation might be necessary for that purpose and, I would suspect, a considerably larger sample size. Notwithstanding my own statistical ignorance, a clearer presentation of this aspect of the report would be useful and add to the strength of the study, even if it were to highlight some of its limitations.

Methods paragraph three has several interesting aspects. That the midwife judged the woman’s distress prior to seeking consent seems appropriate. A good use of human ‘subjectivity’, I would say.

That there were two midwives present for the recording of the line seems to suggest reliability but as the authors mention, in discussion paragraph 8, no measure of inter-rater reliability was conducted. The possibility of inter-rater negotiation, an inter-subjective process, could have confounded this, putatively, objective measurement. The authors are aware of this and do acknowledge it appropriately. What methods paragraph three also suggests is that the line was measured in centimetres units rather than the more precise millimetres. It is not clear why this is so, and this is unfortunate as it might be that more precision in the measurement of line length could have made subsequent paired-correlation more powerful and informative.

Also mentioned at this point, and it seems a reasonable accommodation to human physiological variability, the purple line was to be calculated as a percentage of the total distanced from the anal margin to the nape of the buttocks. Presumably the correlation between progress by VE and descent, was to be paired with the percentage of the line that was purple. I can well believe that the calculation of the point that is putatively the nape of the buttocks was difficult even contentious between two observers and that this aspect of the proposed study was dropped. The omission of this percentage calculation from the remainder of the report however raises the question, what happened to this
aspect of the study? and, would it not be better not to raise this point in the methods if the calculation later proved unhelpful or confounding?

As was mentioned, having two midwives might potentially improve the reliability of the line measurement. What was not described (or discussed) was whether or not one of those two then performed the VE that recorded the cervical dilatation and the descent. The hypothesis of a correlation between purple line length and other indicators of progress is, at least in theory, accepted. Methodologically it might therefore be preferred if the measurements of progress (the VE dilatation and descent and, putatively, the purple line) be blinded. There is every possibility that knowledge of one (the purple line) might skew the subsequent estimation of the other. While the limitations of staffing might well have made this separation of raters impossible or impracticable, the study report should clarify this methodological detail.

Other potential indicators of labour progress have been omitted. These are descent of the head per abdomen and effacement of the cervix (as an estimated percentage effacement or estimated cervical length). These both may have been rejected as problematic from the perspective of sensitivity. Fifths of the head palpable abdominally above the pelvic brim is a relatively imprecise measurement, and cervical effacement very variable, particularly the theorised difference between the primiparous and multiparous cervical os. A rationale for their omission (and any evidence to support this decision) might have been a useful adjunct.

The analysis paragraph clearly explains the need for repeated measurement of each variable. It may be that the initial power analysis should have utilised this requirement (that there be x number of women with repeated progress measures) as the basis for the calculation of a statistically powerful sample size.

The tables 2 and 3 divide and tabulate the data into discrete categories 1-2 cm etc. While this is useful for a quick eyeballing of the figures, it is not at all clear that the analysis did not also categorise and combine the date sets in a similar manner. I can only assume that the data, as paired for correlation, were analysed discretely when calculating the r and p values. As presented, with SD values for each 2cm cervical dilatation category, one is left with the feeling that data was merely clumped into these categories. One is left then wondering why they were clumped in 2cm rather than 1cm intervals, and how precisely the cervical dilatation measurements were recorded (to the nearest cm or in ranges eg 2-3 cm) and how for example 2.5 cm might have been categorised. Each of these details have potential for significantly refining, or coarsening, the power of the putative correlational relationship. This echoes too the imprecision of the initial measurement of the line in centimetres (or to the nearest centimetre).

Results

Results paragraph 6 discusses table 2. As mentioned earlier in this review, no further reference is made to the percentage of the total buttock cleft which was outlined in methods paragraph 3. With regard to results paragraph 6, which refers to those whose labour has been induced, the apparent disappearance of
the purple line (from 80% to 52.2%) is puzzling. Might this be due to methodological inconsistency? ie. a tendency for the observations to be less rigourously carried out where other interventions take over? or due to some confounding variable such as the use of epidural analgesia and / or an associated loss of mobility or upright posture in labour? These possibilities are not discussed, nor any detail supplied that allows the reader to out rule them.

Discussion paragraph one contains the suggestion that the line appears just above the anal margin at 3-4 cm cervical dilatation, while tables 2 and 3 would seem to suggest that for one quarter of the examples it appears at 1-2 cm and even at that point may be from 5 (spontaneous onset) to 8 (IOL) cm long. It would seem that a combination of measurement imprecision and tabular categorisation (both alluded to earlier) serve to undermine the assertion of a gradual onset from the anal margin. While this inconsistency between statistical correlation and graphical representation may be an anomalous artefact, it would perhaps have been useful to present graphically the correlational relationship between the variables for all four sets of data – for the spontaneous onset and induced groups and for cervical dilatation and descent.

There seems in table 3 to be an outlier or an accident in printing – while a single individual may have had a purple line of 12 cm before IOL – it may be that this is the result of an administrative error recording the total cleft rather than the purple line. Even if not, is it likely that the woman will have had a series of 12 examinations all at < 1 cm? - perhaps back referencing to the original data set might clarify or rectify this confusing outlier. Either way a mechanism for statistic ally managing or minimising the effects of such extreme outliers maybe possible.

Weighting of those with multiple measurements (discussion paragraph 2) makes intuitive sense but simple reference to Bland and Altman [37] does not assist the reader any further.

Discussion paragraphs 4 and 5. The refusal rate is indeed high but it is not clear whether all refusals took place after the midwives’ assessment that the woman was not distressed, as was explained earlier in methods paragraph 3, or taken as refusal by the midwife because of lack of ethically informed consent in advanced labour. If the latter, the high refusal rate might be indicative of an ethically sound intervention.

The remainder of the discussion section and the conclusion draw appropriately on the data presented, ask relevant questions of the data, and expand the remit of future research into the arena of the acceptability of purple line measurement to women and clinicians.

In conclusion, this study strives to move forward the exploration of the purple line as a progress indicator in labour. As such, this study builds on the work of Byrne and Edmonds [32] and attempts to refine the investigation beyond whether the line appears. Shepherd et al demonstrate that it is visible in 25% of women sampled at 1-2 cm dilatation and in 70-80% towards the end of first stage. They have demonstrated an increase in the length of the purple line as labour
progresses and a positive correlation between the length of the line and progress in labour as measured by classical means (VE and descent). The correlation is only ‘moderate’ \( r = +0.36 \) to \(+0.42\). These findings are a considerable way forward in the investigation of the purple line phenomenon. Several methodological aspects of appropriate study of the phenomenon have been addressed and several more arise from review / critique of the study. These too add to the corpus of work that could lead to the broader use of this phenomenon as an adjunct to contemporary, less invasive, in-labour care.

What remains to be answered, by these authors, or others interested in advancing non invasive methods of assessment of progress in labour, is; what might be regarded as a sufficiently ‘good’ correlational relationship? What power does a correlation of \(+0.5\) for example have in a clinical, rather than a statistical, context? Where a purple line has been seen and has been recorded as elongating for example, can this (without invasive VE) be accepted as indicating progress in labour? Studies such as this begin to answer these questions. Concern for, and increasing refinement of, methodological and analytical rigour, increases the potential for the appropriate use of the purple line phenomenon. This study is to be heartily welcomed as truly midwifery research, instigated by midwives, fully coherent with a midwifery philosophy of being with woman and protective of birthing normality.

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