Original Article

Assessing Postpartum Perineal Wound Healing: A Comparison between Digital Imaging with MATLAB and the REEDA Scale

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ABSTRACT

OBJECTIVE: To compare the assessment of postpartum perineal wound healing using a digital imaging perineal wound scanner (integrated with MATLAB data processing) versus the traditional REEDA (redness, ecchymosis, edema, discharge, approximation) clinical observation scale.

METHODOLOGY: Utilizing a quasi-experimental pre-post design without a control group, the researchers applied non-parametric statistical tests: the Wilcoxon signed-rank test for paired data to assess the same subjects using both methods, and the Mann-Whitney U test to compare healing outcomes. The research was conducted at the Pantai Cermin Health Centre in Serdang Bedagai Regency with an initial sample of 50 postpartum women recruited through purposive sampling from July to October 2021. Inclusion criteria specified participants with grade 2 perineal wounds, while those with diabetes or other relevant comorbidities were excluded. Ultimately, 45 subjects' images were used for analysis, after 5 were dropped due to processing issues. The assessment was performed on postpartum mothers on days 2 and 10, encompassing imaging techniques alongside observations via the REEDA scale.

RESULTS: The results indicated statistically significant differences in mean wound-healing scores between the two methods on the analyzed days. The REEDA method showed a greater wound improvement percentage of 56.10 compared to 34.90 for the MATLAB method, with a significance level of $P < 0.05$.

CONCLUSION: Digital imaging is the latest innovation for assessing the condition of perineal wounds, enabling rapid determination of treatment strategies.

KEYWORDS: Healing, mother, perineal, postpartum, Wound.

INTRODUCTION

Lacerations in the birth canal, often termed perineal wounds, occur in roughly ninety percent of women after vaginal delivery[1,2]. These injuries may occur spontaneously or as a consequence of medical procedures. Several factors, including parity (the number of previous births), the techniques employed during delivery, and any assistance rendered during the birthing process, can affect the nature and severity of the perineal injuries experienced[3,4]. For successful treatment and minimizing of pain, which can cause morbidity, the correct care of perineal injuries is vital. Consequences that may ensue following wound repair of obstetric anal sphincter injuries are as follows[5]. Postpartum maternal mortality and morbidity take six weeks to manifest their peak, returning towards the day of birth[5–7]. Successful treatment demands accurate diagnosis, proper repair methods, and the skill of an experienced professional[3]. Indications clinicians receive for perineal trauma in obstetrics. Biomechanical modeling has pinpointed crucial areas vulnerable to injury, including the superior perineal body[8]. A large number of complications following the repair of obstetric anal sphincter injuries are caused by infection (4.4%) and dehiscence (6.9%)[3,5,9,10]. Therefore, precise and prompt evaluation of wounds is essential for achieving the best possible healing outcomes[11].

METHODOLOGY

In this study, a digital imaging of perineal wound scanner tool with MATLAB as an image data processor was used, which differs from the conventional approach, which involves obstetric staff subjectively assessing using the REEDA scale (Redness, Edema, Ecchymosis, Discharge, Approximation). Assistive devices instruct postpartum mothers to take perineal wound image data in a sitting position using the perineal wound scanner tool, which captures images of the perineal wounds, which are then analyzed using the MATLAB application. This study uses a quasi-experimental pre-post design without a control group, using purposive sampling with inclusion criteria set by the researchers, including grade 2 perineal wounds, with exclusion criteria such as a history of diseases such as diabetes, sphincter injuries, or wounds to the anus. Written consent from research subjects was obtained after the intervention

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was explained, with participants signing the informed consent form.

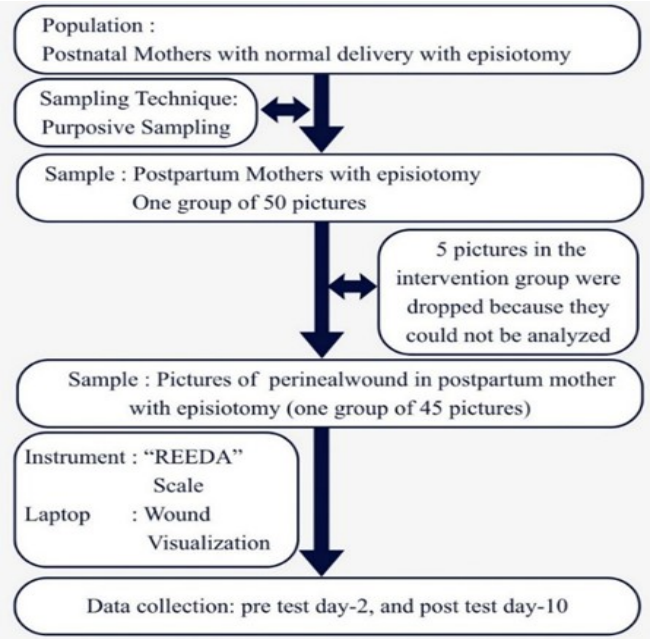

Figure 1: Flow of Sampling

The research was conducted in the working area of the Pantai Cermin Health Centre in Serdang Bedagai Regency. The initial sample size in this study was 50 postpartum women. This was due to the limited travel distance to carry out interventions during the COVID-19 pandemic situation and the establishment of lockdowns in several red zone areas in Medan City, so the final sample in this study amounted to 45 wound images. Screening was carried out on postpartum mothers on days 2 and 10 using perineal wound imaging and the REEDA scale observation sheet. In the perineal Wound, the area, exudate value, perineal wound tissue type, and perineal wound healing status were assessed. Steps for wound identification included preprocessing and the extraction of texture features using GLCM. Cross-validation was used to split the data into training and test sets, and identification was performed using a PNN to determine the classification model and calculate accuracy. The development of this technology is the first step toward implementing a mathematical model in MATLAB. In this study, screening was carried out using a Sit Perineal Wound Scanner with a tool builder material holder, which was positioned higher in the back seat area. This position will open the thighs and labia so that the object of animation can be seen.

Figure 2: Sit Perineal Wound Scanner

The data collection results were analyzed using the Statistical Package for the Social Sciences (SPSS) version 16, with the Wilcoxon signed-rank test, and comparisons were done using the Mann-Whitney U test. The final sample in this study consisted of 45 images, as five images could not be processed and

Table I: Comparison of respondent characteristics and perineal wound assessment on days 2 and 10

Component	f	%	Mean±SD	Day-2 (*p-value*)*			Day-10 (*p-value*)*		
				Wound area	Wound Category	REEDA Score	Wound area	Wound Category	REEDA Score
Mother's Age	45	100	27.76±5.593	0.312	0.08	0.234	0.312	0.279	0.385
17 Years- 39 Years									
Parity				0.394	0.317	0.533	0.265	0.125	0.357
Primgravida	19	42.2	2.13±1.307						
Multigravida	24	53.3							
Grandemultigravida	2	4.4							
Body Length				0.373	0.568	0.203	0.373	0.48	0.383
45cm-55cm	45	100	49.84±2.056						
Weight				0.344	0.852	0.518	0.344	0.868	0.99
2500gr-3800gr	45	100	3.182±0.302						
Episiotomy				0.43	0.877	0.695	0.43	0.938	0.339
Yes	10	22.2	1.78±0.420						
No	35	77.8							

**Spearman's Rank*

were therefore dropped. The duration of data collection was five months (July-October 2021).

RESULTS

Table I below presents a comparison of respondents' characteristics and assessment of perineal wounds using conventional and application methods on the 2nd and 10th days. The majority of postpartum mothers were primigravida (19 respondents, 42.2%); the rest were multigravida (24 respondents, 53.3%); and grande multipara (2 respondents, 4.4%). No significant relationship was observed between parity and wound healing characteristics such as wound area, wound category, and REEDA scores on day 2 and day 10 ($p > 0.05$). In the episiotomy procedure, 35 respondents (77.8%) were postpartum mothers who did not undergo an episiotomy, while 10 respondents (22.2%) did. The crosstab table shows no significant relationship between the episiotomy procedure and wound-healing characteristics, including wound area, wound category, and REEDA score on days 2 and 10.

Table I above compares respondents' characteristics and assessment of perineal wounds using conventional and application methods on the 2nd and 10th days. The majority of postpartum mothers were primigravida (19 respondents, 42.2%); the rest were multigravida (24 respondents, 53.3%); and grande multipara (2 respondents, 4.4%). No significant relationship was observed between parity and wound healing characteristics such as wound area, wound category, and REEDA scores on day 2 and day 10 ($p > 0.05$). In the episiotomy procedure, 35 respondents (77.8%) were postpartum mothers who did not undergo an episiotomy, while 10 respondents (22.2%) did.

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Based on the Shapiro-Wilk test for data normality (all $p < 0.05$), the non-parametric Wilcoxon signed-rank test was used for the paired data comparing MATLAB and REEDA at the same time points on day 2 and day 10 in **Table II** below.

Table II: Comparison of wound healing difference assessment using conventional and application methods on days 2 and 10

Method	Day2 Mean±SD	Day 10 Mean±SD	*P-Value**
REEDA Scale	11.37	5.93	0.0001
Scanner Sit Perineal Wound	149938.93	134154.44	0.279

**Wilcoxon Signed Rank*

Wound-healing assessed using MATLAB analysis showed a statistically non-significant reduction in wound area ($P > 0.05$). This was due to considerable variability in wound area between subjects. Meanwhile, conventional measurement of wound healing using the REEDA tool showed a significant decrease in scores (P of 0.0001). The REEDA score successfully detected more consistent Wound healing data across all subjects.

The difference in the assessment of the perineal Wound using the MATLAB method and the conventional method (REEDA) on days 2 and 10 is shown in **Figure 3**. Figure (3a) shows an assessment of wound repair using a MATLAB application by measuring the surface area of the Wound on the 2nd and 10th day. Figure (3b) shows an assessment of wound repair using the conventional method, the REEDA scale, on the same day. In Figures (a) and (b), it can be seen that there was an improvement in the perineal wound, with a decrease in the surface area of the Wound and the REEDA score on the 10th day.

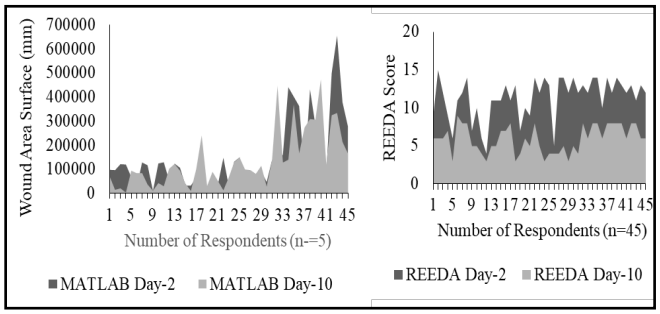

Figure 3: Assessment of perineal wound repair using MATLAB (a) and using the conventional REEDA method (b)

Based on the results of the Mann-Whitney U test, the REEDA method recorded a lower mean rank of REEDA 56.10) than that of MATLAB (34.90). This difference is highly significant ($p < 0.0001$), indicating that REEDA is more dynamic than MATLAB, as evidenced by the greater reduction in scores during the wound-healing observation period from day 2 to day 10. Both methods demonstrated similar ability to capture changes in wound-healing scores from day 2 to day 10; however, the more detailed nature of the MATLAB method enabled it to detect changes with greater precision.

Table III: Comparison of Wound healing percentages using the MATLAB and REEDA methods from day 2 to day 10

Method	Mean±SD	Mean Rank	N	*P-Value*
REEDA Scale	4.488±116.205	56.10	45	0.0001
Scanner Sit Perineal Wound		34.90		

** Mann-Whitney U*

DISCUSSION

The number of previous deliveries significantly affects pregnancy outcome and is typically divided into one, two, or three babies at a time. In twin pregnancies, research isotope studies found that more children tended to be better for the outcome of both mother and infant[28]. Smithson SD et al.[13] show that women

with higher parity have a lower risk of postpartum depression. However, if it is a grand multipara, there is an increased risk of all three bad perinatal outcomes: stillbirth, macrosomia, and even a finished pregnancy[29,30]. Dasa TT 2022[14] take a slightly different view of this issue. Parity also affects the gut microbiome of mothers during pregnancy. As parity increases, their pathologic hygiene conditions are more quickly replaced by industrial hygiene conditions[32,33]. Among advanced maternal-age women, multiparity with an interpregnancy interval ≤5 years is protective against adverse neonatal outcomes[33]. Interestingly, parity is not a determinant of pain relief use during labor[35]. Multiparity is associated with lower risks of adverse birth outcomes than nulliparity. Based on the results of the parity characteristic test on the characteristics of wound healing, it was obtained (p-value> 0.05), which means that tissue adhesives showed promise in promoting perineal wound healing and pain relief, particularly when combined with sutures for episiotomies. Postpartum perineal healing and related factors show mixed results. Parity was not found to significantly impact postpartum wound healing in women with inflammatory bowel disease.

Many factors can impede wound healing: dietary conditions, wound condition, and knowledge of wound care. Using the characteristic action test, results showed no significant relationship between parity and the traits of perineal Wound healing in postpartum mothers (p-value > 0.05). External injuries are quickly identified, while internal injuries can be much harder to assess[12]. Gupta R et al [19] found that a prognostic model based on wound image characteristics outperforms traditional clinical descriptors in estimating a patient's risk of Wound healing. Derivatives of the perinatal period have been found to have the potential to dampen inflammation and promote the healing of wounds. Assessment of perineal wound healing is an important way to determine the best treatment, but there is not a wealth of high-quality research on it, as there should be[14,17]. According to wound-healing methods, perianal wounds are classified into many types. One of these is to employ the REEDA scale observation sheet for the subjective assessment[17].

The REEDA scale is thus comprised of redness, oedema, ecchymosis, discharge, and approximation, and is frequently employed to evaluate the course of wound healing in various clinical contexts[18-21]. For perineal injuries, the REEDA scale comprises redness, swelling, ecchymosis, discharge, and approximation[22]. Further education is essential for professional healthcare providers related to the management of trauma on the perineum, particularly concerning obstetrical anal sphincter injuries[23-26]. Technical developments mean that old wound care practices that rely solely on visual inspection are already obsolete[24]. Several imaging modalities produce large amounts of valuable information within wound healing processes. Optical coherence tomography and near-infrared spectroscopy are just two examples[25]. It is critical to develop better means for predicting outcomes of trauma healing and keep a close eye on the changing environment within a wound[26]. Commercial wound assessment systems are more effective than traditional systems for producing objective results [27].

After all, the nature of episode scars is usually about right angles, which allows them to connect tightly. In this study, two methods were used to assess the repair of perineal wounds using the REEDA score. The application method proceeds by manipulating digital photographs of perineal wounds and using MATLAB to identify image sources. MATLAB is a programming language that features numerous built-in mathematical, matrix, and equation operations, and is extensively used in specialized domains, facilitating program development for users. The results of tests carried out in MATLAB show that this method can identify wound images with an accuracy of up to 85% [12]. The algorithm used to create the perineal wound image recognition system represents categories as groups based on the primary color of perineal wounds and of wound characteristics derived from 11 options. Dark red indicates healthy tissue and smooth blood flow; red oxidation indicates the same; pink indicates inadequate blood flow and anemia; pale pink indicates the same. Eleven forms of perineal wounds are listed: blue-grey as swelling, trauma; purple as enlargement, swelling, high bacterial level, trauma; black as necrotic tissue; chocolate as nonviable tissue; yellow as non-regenerating (nonviable), moist, exfoliating; green as the network cannot regenerate; and white as maceration, poor blood flow.

The RGB values for red, green, and blue are also changed into this form after extraction. Whichever of these courses is taken will result in a histogram of the one-dimensional grey image matrix. Although MATLAB is a genuine tool, a platform like this, combined with specialized image-processing hardware, can do things more efficiently. If the image matrix is interpreted, only the red matrix is seen (the green and blue are all zero), whereas before or after it was done in other ways in grey[12]. The wound image becomes a binary image for the measurement of the wound area. Objects are processed in terms of shape and structure; image filters are used to gather information from representative pixels in the image. After designating the wound area for measurement, edge detection software is executed, followed by image reconstruction to yield a single, accurate analysis area. Image digital filtering was performed on RGB (3-D) images using the imfilter function and on grayscale or 2-D images in daylight. The filters used were 12×12 matrix-filled Gaussian filters; it was then suggested that, after the reconstruction procedure, digital holes should not be filled. The perimeter of the Wound in the perineal region is measured using digital image processing. This function is aimed at probing

into the cumulative effects of reductions in perineal wound area. In the edge detection step, object selection is accomplished — and this operation is equivalent to the MATLAB edge command[12].

The traditional REEDA scale (Redness, Edema, Echymosis, Discharge, Approximation) is used to evaluate the healing of perineal wounds. The REEDA assessment includes redness of the suturing area, redness in the adjacent skin, oedema (swelling; pitting oedema or nonpitting, both indicating abnormal fluid accumulation), ecchymosis (blueness or bruising caused by blood extravasation under the skin, forming round, flat purple spots), and discharge (excretion from the wound site). The approximation is that there should be a blurring of sutured tissue. Make sure to score each factor on a scale from 0 to 3; then, doctors and nurses review the scores. A total score of 15 indicates severe tissue trauma and the most adverse signs (poor healing), while 0 represents the best for perineal wound healing[12]. This study compared the two methods to see which outperformed the other. The results showed that all wounds healed well, with only REEDA values on par with textile operation funds. However, there is a difference between the means (mean ranks) of test results with the REEDA scale on days 2 and 10, a difference of 1.00 units higher than when employing catheters, whereas it is only 0.08.

One possible reason is that the REEDA scale method provides only an estimate when it provides two surfaces, inside and out, with no indication of how these surfaces are distributed among different tissue types. Profit margins readily explain the change in electronic health records, and digital tools can improve healthcare delivery and workforce management. However, the epidemic responses and health worker preparedness evaluations in these contexts are only spatially patchy. There are gaps where data have not yet been collected or are simply missing in time frames, which can change rapidly — overnight from bad to worse or—occasionally—back again. It also emphasizes national governments' limited responses to workforce supply shortfalls and exploits their vulnerabilities.

Standardized data collection and evaluation approaches should be used to study diversity measures and workforce registries, while greater attention should be paid to evidence-based government programs. To achieve this, national policies must first consider when metropolitan areas may experience new health risks at short notice, with disastrous consequences for all concerned, without forewarning. Developing practical models and approaches that standardize how we measure health workers' performance and capability-building can help solve this problem. Finally, scholars conclude that although some applications do indeed offer hope to health workers, others (particularly certain forms of traditional practice still in wide use) seem to have little effect on matters of diagnosis. Overall, these studies demonstrate the potential for mHealth solutions, but they also show that more rigorous research and standardized evaluation methods are needed in low-resource settings.

Nurses lack knowledge of chronic wound management, suggesting they need more training in this area, as there is very little wound instruction for medical students. In clinical practice, this leaves them unequipped. Health workers have long played an important role in assessing and managing postpartum wounds. However, they face difficulties, such as a lack of standards, in providing quality care. The lack of a supply of workers hinders quality care in domestic help-seeking training, instantly putting them out of business. Community health workers can be encouraged to improve attendance rates for postpartum care. Factors affecting PPH prevention include beliefs, knowledge, and socio-economic status.

Midwives' structured perineal wound assessment and repair education can enhance confidence and skills. Existing interventions show promise, but more high-quality research is needed to assess the long-term management of perineal injury and patient satisfaction[17]. This will help doctors select the most effective treatment, avoid side effects, and make treatment more cost-effective. The method of applying wounds is different from this one. Automatic wound analysis using colour image processing makes wound treatment more objective and grounded in reality. Compared to manual methods, this method is considered more objective for automatically analyzing wounds using colour image processing. Also, the authenticity factor is very high across all three measures of wound color: the K-means value and the method critical point distance. Wounds are categorized of color, using the RYB (Red-Yellow-Black) color scheme[12]. Using MATLAB provides highly reliable, continuous numerical data, which is statistically stronger than the ordinal data provided by REEDA.

The Wound generally has a non-uniform mixture of yellow and black necrotic tissue and red granulation tissue. To assess the wound-healing area, one essential factor is the percentage of each colour region. The percentage of red in the black circle (where we cannot see any green) represents an area of complete healing or the total treatment volume. The advantages of this method are that it is objective, more accurate, reproducible, and very convenient [13]. So, even though our results were the same when different health workers examined them, a health worker concerned about the patient's welfare and health can be satisfied using digital image applications. As an important indicator of wound healing, a previous study by Girsang BM 2022[11] found that health workers were satisfied with using digital image applications because they are easy to use for screening perineal wounds and provide results that can measure changes in wound area over time. The

correlation of both MATLAB and REEDA scores with the patient's long-term quality of life assessed whether these early measurements accurately predict long-term issues like pelvic floor dysfunction or dyspareunia (pain during intercourse).

CONCLUSION

Perineal wound assessment using two methods, application and conventional, with the REEDA scale, showed an improvement in the characteristics of the perineal wound healing status from day 2 to day 10. The results of the Mann-Whitney U test indicate a difference ($P < 0.05$) in wound repair assessment between the MATLAB application and the REEDA method. This shows that the application of digital imaging can be used to assess the healing status of the perineal Wound, as one of the latest innovations in Wound assessment, enabling a treatment strategy to be decided quickly. Digital image application methods are straightforward and provide objective, more accurate results. Although the percentage of wound healing observed was lower than that achieved with the REEDA method, the REEDA method used a calibrated measuring instrument. In contrast, the REEDA method relied on individual observations, which are subject to varying degrees of subjective interpretation.

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AUTHOR CONTRIBUTION

Girsang BM: Literature search, Study design and concept, Data analysis, Writing - original draft, Writing - review & editing

Elfira E: Questionnaire design, Data collection, Formal analysis, Writing - original draft, Data interpretation

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