

A Randomized Trial Comparing Coconut Oil as a Low-Cost Alternative to Commercial Ultrasound Gel

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1.0 Background and Rationale

Ultrasound is a fundamental diagnostic tool in Obstetrics in both resource-rich and resource-limited settings. One barrier to sustainable ultrasound use in low-resource settings is access to the necessary consumable goods, specifically ultrasound gel, to serve as the coupling medium required to conduct the sound waves between the ultrasound probe and the patient's tissue to produce quality images. In low-resource settings, unreliable access to commercial ultrasound gel and its high cost can limit routine use of ultrasonography.

Coconut oil is a low cost and widely available alternative to commercial ultrasound gel that additionally has been shown to be moisturizing, antibacterial, anti-inflammatory, and safe. There are no studies to date that compare the quality of ultrasound images obtained using coconut oil and commercial ultrasound gel. There are also no studies that evaluate patient satisfaction with the use of coconut oil as a coupling medium for OB ultrasounds.

Coconut oil is isolated from the kernel or meat of mature coconuts harvested from the coconut palm (*Cocos nucifera*). It has been shown to be as effective as mineral oil as a moisturizer to treat mild to moderate xerosis [1], however, it has the additional benefit of being antiseptic. Coconut oil is made up of medium-chain fatty acids which are effective in destroying lipid-coated bacteria [2]. Studies have shown that lauric acid is the most inhibitory saturated fatty acid against gram-positive organisms such as the streptococcus and staphylococcus species that are the most common causes of bacterial skin infections. Coconut oil happens to be the highest natural source of lauric acid, making up almost 50% of coconut's fat content [3]. Cellular studies have also shown that monoglyceride derivatives of lauric acid exhibit antiviral and antifungal activity [4]. Additionally, coconut oil increases the expression of skin barrier molecules and collagen, enhancing skin's barrier function and improving hydration by preventing water evaporation [5]. The annual average cost of coconut oil in 2020 per the World Bank Commodities Price Data was 1,010 USD/mt which can be converted to 0.0010 USD/g or 0.02 USD/20g [6]. At Indiana University Hospitals, the standard ultrasound gel used, Aquasonic 100 (Parker Laboratories, Inc., Fairfield, NJ), is sold in 20g packets for 0.34 USD. Therefore, the standard ultrasound gel used at Indiana University Hospitals is 17 times more expensive than coconut oil by weight. Of the world's 195 countries, 95 produce coconuts, with the Philippines, Indonesia, and India producing about 70% of the world's total copra, the dried coconut kernel from which coconut oil is made [7]. Coconut oil is a readily accessible resource in these countries and most countries worldwide.

We plan to perform a blinded equivalence study to formally evaluate coconut oil as an alternative to commercially produced ultrasound gel by comparing the quality of ultrasound images using each respective coupling media. Additionally, we aimed to assess patients' satisfaction with the use of coconut oil for this purpose. This study will use organic refined coconut oil.

2.0 Objectives

2.1 Primary Objective

- To evaluate the quality of ultrasound images obtained using coconut oil compared with commercial ultrasound gel.

2.2 Secondary Objective

- To assess patient acceptability of coconut oil as compared to commercial ultrasound gel.

3.0 Outcome Measures/Endpoints

3.1 Image Quality

- Paired images will be displayed side by side in random order and each of the following parameters will be assessed using a 10 cm visual analog scale by a blinded reader:
 - Resolution – sharpness/crispness of image, lack of haziness
 - Image detail – clarity of organ outlines and ease with which boundaries of structures are seen
 - Total image quality – contrast of solid and fluid-filled structures and absence of noise
 - Clarity/definition:
 - BPD/HC – thalami and CSP
 - Abdominal circumference – umbilical vein, portal sinus
 - FL - femur bow definition

3.2 Patient Acceptability

- A 10-question, 5-point Likert scale survey will be administered to all participants following their ultrasound with both coupling mediums to compare acceptability.
- See **Appendix 1** for patient survey.

4.0 Eligibility Criteria

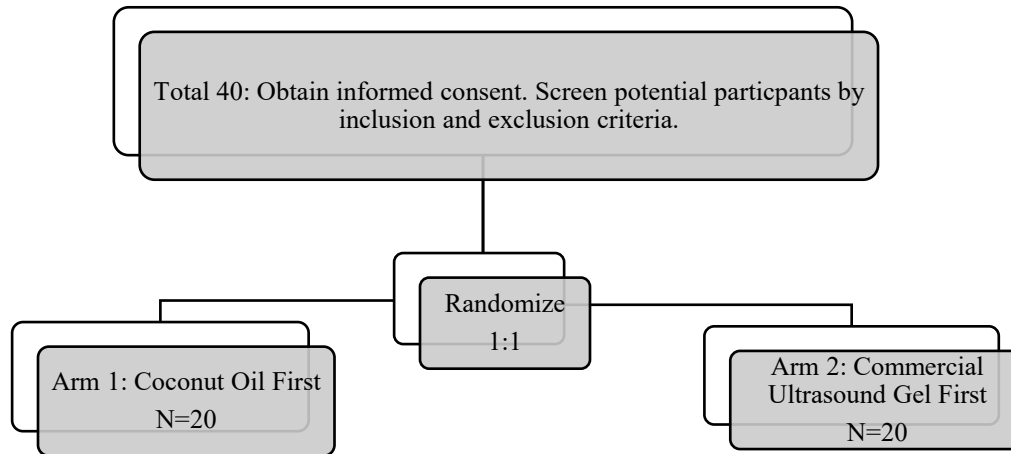
4.1 Inclusion Criteria

- Singleton pregnancy
- Patients presenting for an anatomy or growth US
- Patients assigned to the pre-determined ultrasound suite that will stay constant throughout the study so that the same ultrasound machine is used to obtain all images.

4.2 Exclusion Criteria

- Allergy to coconut
- Active inflammatory dermatologic conditions (dermatitis, eczema, or psoriasis)
- Multiple gestation pregnancy

5.0 Study Design



6.0 Enrollment/Randomization

- 6.1 Patients assigned to have their anatomy or growth ultrasound at the Maternal Fetal Medicine clinic in the Riley Outpatient Center will be approached to participate after the patient is roomed in the ultrasound suite and while they are waiting for the ultrasound technician to begin the scan.
- 6.2 The patient will be randomized to either starting the exam by first obtaining the study images with coconut oil and then proceeding with the standard ultrasound using commercial ultrasound gel or starting with the scheduled ultrasound using the commercial ultrasound gel and ending by obtaining the study images using coconut oil.
- 6.3 The same ultrasound machine will be used to obtain all images in this study. This means that only patients assigned to have their imaging in the ultrasound suite with the “study ultrasound machine” will be included in the study.

7.0 Study Procedures

- 7.1 Recruitment and consent will take place in the ultrasound suite after the patient’s vitals are collected and while they are waiting for the ultrasound technician to begin the ultrasound scan.
- 7.2 After the patient is consented and all questions are answered, the patient’s information will be entered into a RedCap and they will be randomized to either starting the scan by first obtaining the required study images with coconut oil and then proceeding to the standard ultrasound using commercial ultrasound gel (Arm 1) or to starting with the scheduled ultrasound using the commercial ultrasound gel and ending by obtaining the required study images using coconut oil (Arm 2).

- 7.3 Whether assigned to Arm 1 or Arm 2, prior to the collection of the study images using coconut oil, the participant will be handed a small plastic cup with a pre-measured amount of coconut oil and they will be asked to warm it in their hand for at least 2 minutes. They will then apply the coconut oil to their own abdomen with their hands prior to the ultrasound technician obtaining the required images.
- 7.4 The ultrasound technician will collect 3 extra images for study purposes only using the coconut oil. This will only require 5-10 extra minutes of your time.
- 7.5 The ultrasound technician will drag the 3 fetal biometry images obtained with coconut oil and the 3 fetal biometry images obtained with commercial gel to the bottom of the set of images obtained throughout the study. They will label the images according to their randomization. For example, if randomized to coconut oil first followed by commercial gel, the coconut oil images will be labeled 1 and the commercial gel images labeled as 2. The images will be paired next to their counterpart.
- 7.6 While the images are being labeled and sorted, the patient will quickly fill out the short Patient Acceptability Survey.
- 7.7 The patient will be thanked for their participation and continue with the scheduled visit. A towel will be provided to clean off ultrasound gel or coconut oil as needed.

8.0 Reportable Events

- 8.1 Any adverse events or unanticipated problems involving risk to participants will be reported to the Indiana University Human Research Protection Program (HRPP) at (317) 274-8289 or via email at irb@iu.edu.
- 8.2 An adverse event (AE) for this study would be a side effect caused by the coconut oil used in the study. A serious adverse event (SAE) would be an anaphylactic reaction to the coconut oil used in the study. Collection of AEs and SAEs will begin at the start of interventions.

9.0 Data Safety Monitoring

- 9.1 Images obtained for the study will be saved in the standard way, using the Viewpoint software.
- 9.2 Patient information will be entered into a secure RedCap: Name, MRN, BMI
- 9.3 Patient acceptability surveys will be entered directly into RedCap using an Ipad and dual-factor authentication.

10.0 Study Withdrawal/Discontinuation

- 10.1 At any time during the study, the participant can decide to withdraw themselves from the study at which point they will receive the ultrasound for which they were scheduled without the use of coconut oil as the ultrasound coupling media. Withdrawing from the study will not alter the care the patient receives.

11.0 Statistical Consideration

Study Design

There are 3 views for a given ultrasound, 2 raters will rate each image on 4 different factors, and each person will receive ultrasound using both types of medium (Coconut oil vs Commercial gel). Only image raters will be blinded to the medium used. Patients will be provided the two mediums in a different order (although the specific images will be in the same order). Quality will be estimated by two raters. Patient satisfaction with both mediums will be asked at the end of the ultrasound session and will ask patients how satisfied they were with each specific medium (Coconut oil vs Commercial gel) since they aren't blinded to type.

The study statistician will create a randomization list (A vs B) as to which medium each woman will receive first.

4 factors: Quality (Equivalence outcome), Resolution, Detail, Specific anatomic view (Based on a given image). All factors other than quality will be analyzed with a standard superiority hypothesis.

The primary hypothesis is that image quality (overall) will be equivalent between the two types of ultrasound medium. This will be tested using the within-patient contrast obtained from a linear mixed model.

Report Definitions

N is the number of items sampled from the population. Effect Size: $d = (\mu_1 - \mu_2) / \sigma$ is the effect size. Cohen recommended Low = 0.2, Medium = 0.5, and High = 0.8. σ is the assumed population standard deviation of the paired differences. Alpha is the probability of rejecting a true null hypothesis.

Our primary hypothesis for equivalence:

$$H_0: \delta \leq -10 \text{ or } \delta \geq 10 \text{ vs. } H_1: -10 < \delta < 10$$

With N = 40, an equivalence test of the mean difference in image quality (measured on 0 to 100 scale) from a paired design using two one-sided t-tests (which should provide similar power to the contrast from our model), achieves 83% power at .05 significance level when the actual paired difference is 5 and the estimated standard deviation of paired differences is 12 when equivalence limits are -10 and 10. For the continuous outcome of patient satisfaction, we will have 80% power to detect an ES = 0.45 with type I error set at .05 based on a paired t-test which provides similar power to the contrast from our model.

Statistical analysis

Descriptive statistics of image outcomes of quality, resolution, and detail will be summarized overall and separately by medium. For the specific anatomic view, this will be estimated separately for each view by medium. For the primary outcome, a linear mixed model will be fit to quality, including effects for view and medium (Coconut oil vs Commercial gel and a random rater effect. To test the hypothesis, the within-person mean difference in image quality for Commercial gel vs Coconut oil will be estimated along with associated **90%** confidence interval. If the confidence interval is inside the equivalence region of [-10, 10], we will reject the null hypothesis and conclude Coconut oil is equivalent to Commercial gel with regard to quality.

For all other image outcomes, a similar model will be fit except the mean difference in the outcome between mediums and associated **95%** confidence interval will be reported as we do not a priori know which medium will be better. Therefore, we report standard superiority hypothesis with type I error set at 0.05. For the outcome of the specific anatomic view, the model will only be fit for that specific image, thus the model will not contain the effect of view. All models will be examined for fit.

12.0 Statistical Data Management

12.1 All data will be collected and entered directly into RedCap and protected with dual-factor authentication.

13.0 Privacy/Confidentiality Issues

13.1 Recruitment, consent, and study interventions will take place in a private ultrasound suite.

13.2 All study information and data will be securely kept in a RedCap database.

14.0 References

- 1) Agero AL, Verallo-Rowell VM. A randomized double-blind controlled trial comparing extra virgin coconut oil with mineral oil as a moisturizer for mild to moderate xerosis. *Dermatitis*. 2004;15(3):109-116. doi:10.2310/6620.2004.04006
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- 3) Kabara JJ, Swieczkowski DM, Conley AJ, Truant JP. Fatty acids and derivatives as antimicrobial agents. *Antimicrob Agents Chemother*. 1972;2(1):23-28. doi:10.1128/AAC.2.1.23
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- 5) Kim S, Jang JE, Kim J, et al. Enhanced barrier functions and anti-inflammatory effect of cultured coconut extract on human skin. *Food Chem Toxicol.* 2017;106(Pt A):367-375. doi:10.1016/j.fct.2017.05.060
- 6) World Bank Commodities Price Data (The Pink Sheet). Commodity Prices. <https://thedocs.worldbank.org/en/doc/5d903e848db1d1b83e0ec8f744e55570-0350012021/related/CMO-Pink-Sheet-July-2021.pdf>. Published July 2, 2021. Accessed July 13, 2021.
- 7) ["Crops"](#). FAOSTAT. Retrieved 18 December 2020. Countries - Select All; Regions - World + (Total); Elements - Production Quantity; Items - Coconuts; Years - 2018 + 2017 + 2016

15.0 Appendix 1

Participant Survey:

Circle your answer to the questions below.

Ultrasound Gel:

- 1) The ultrasound gel used during the scan was messy.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 2) I experienced itching/burning/redness from the ultrasound gel used during the scan.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 3) The ultrasound gel was easy to remove after the scan.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 4) I like how my skin feels after using the ultrasound gel.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 5) I would have a scan with the ultrasound gel again.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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Coconut Oil:

- 1) The coconut oil used during the scan was messy.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 2) I experienced itching/burning/redness from the coconut oil used during the scan.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 3) The coconut oil was easy to rub in after the scan.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 4) I like how my skin feels after using the coconut oil.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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- 5) I would have a scan with the coconut oil again.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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