

Transcervical Foley Catheter with 50-mL versus 80-mL Single Balloon Volume for Cervical Ripening in Late and Post-term Nulliparous Women: A Single Center Randomized Clinical Trial.

ABSTRACT

Objective: To compare the effectiveness of transcervical Foley catheter (FC) with 50-mL versus 80-mL single ` balloon volume for pre-induction cervical ripening in late and post-term nulliparous women.

Methods: A prospective randomized controlled trial was conducted at the Moi Teaching and Referral Hospital, Kenya. It included 120 participants with unfavorable cervix admitted for labor induction. Participants were randomly allocated to pre-induction cervical ripening with intracervical extra-amniotic single balloon FC inflated with either 50-mL (control arm) or 80-mL balloon volume in a 1:1 ratio. The primary outcome was the proportion of women achieving a Bishop score of ≥ 6 at 24 hours from catheter placement. Additionally, the proportion of vaginal deliveries within 24 hours from induction and the duration of induction to delivery were investigated. The trial protocol was registered www.ctr.pharmacyboardkenya.org; PPB/ECCT/2022(277).

Results: Pre-induction cervical ripening using transcervical FC with 80-mL balloon volume was associated with a significantly higher proportion of Bishop scores ≥ 6 at 24 hour compared to 50-mL balloon volume (90% versus 73.3%, OR 3.27 [1.18 – 9.06]). There was no significant difference in the proportion of vaginal deliveries within 24 hours between the two groups (88.3% vs 90%; $p=0.769$). The Kaplan-Meier analysis demonstrated a significantly shorter induction to delivery interval in the 80-mL balloon volume group compared to the 50-mL group ($\chi^2=12.2$, $p<0.001$).

Conclusion: In late and post-term nulliparous women, pre-induction cervical ripening using transcervical FC with 80-mL balloon volume results in a greater proportion of women with favorable Bishop score at 24 hours and a shorter induction to delivery interval compared to 50-mL volume.

Keywords:

Foley catheter, cervical ripening, balloon volume, 50-mL, 80-mL , induction of labor, mechanical method.

INTRODUCTION

In developed nations, approximately one in five childbirths requires obstetric intervention by induction of labor (IOL)(1). IOL is a medical procedure that artificially initiates the process of uterine contraction and cervical dilatation, resulting in delivery of the products of conception. Late and post-term pregnancies (i.e. pregnancies beyond 41 weeks) are common indicators of IOL. These pregnancies are linked to increased risks of labor complications and adverse pregnancy outcomes, including fetal distress, meconium aspiration, and post-partum hemorrhage(2, 3). Compared to expectant management, IOL in late and post term pregnancies can reduce these adverse outcomes as well as the risk of perinatal mortality(4, 5).

A key indicator to predict the success of IOL is cervical ripening, which shortens the duration of labor and increases the likelihood of vaginal delivery(6). At least half of pregnant women who require IOL will need cervical ripening due to an unfavorable cervix(7). The Bishop score, assessed through digital examination, is a standard evaluation method of cervix for favorability for vaginal delivery. The scoring involves assessing cervical dilation, effacement, position, consistency, and foetal head station(7). A Bishop score of less than 6 indicates an unfavorable cervix, which requires cervical ripening prior to IOL.

Embrey and Mollison were the pioneers in publishing on Foley catheter (FC) use for cervical effacement, and dilatation in 1967 (8). Transcervical insertion of FC into the extra-amniotic space stretches the cervix and stimulates the release of local decidual and cervical prostaglandins. In resource constrained settings, single balloon FC is a widely used mechanical method of cervical ripening; favored due to low cost, low incidence of systemic side effects, and low risk of uterine hyper-stimulation (9).

Protocols for cervical ripening with FC employ variable inflation volumes, ranging from single balloon 30mL FC to 80mL double balloon catheters. A recent systematic review that compared efficacy of single balloon FC to a double balloon FC for IOL found no significant difference in rates of vaginal birth nor maternal and perinatal safety outcomes (10). Notably, single-balloon FC is significantly more affordable and widely available.

Variations in single balloon FC inflation volumes during clinical practice potentially influence the efficacy of cervical ripening procedures. There is need for research on efficacy of an 80ml single-balloon catheter for cervical ripening, with particular consideration to parity status. This clinical trial was done to assist in providing greater clinical clarity.

The study objective was to assess the impact of transcervical FC with 50-mL versus 80-mL balloon volume on cervical ripening. This was measured by the proportion of nulliparous women with late and post-term pregnancy who achieved a Bishop score of ≥ 6 at 24 hours from intracervical catheter insertion. Additionally, the proportion of vaginal deliveries within 24 hours from induction and the duration of induction to delivery was investigated.

Null hypothesis (H0): Transcervical FC with 80-mL balloon volume will not result in a significant difference in the proportion of women achieving a Bishop score of ≥ 6 at 24 hours, compared to 50-mL balloon volume.

MATERIALS AND METHODS

Trial design: This randomized controlled trial was conducted after review and approval of the Moi University/Moi Teaching and Referral Hospital-Institutional Research and Ethics Committee (IREC) approval granted on 26th August, 2021 (reference number 3961000)

The trial protocol was registered with the Kenya pharmacy and poisons board PPB/ECCT/2022(277).

The setting was the Moi Teaching and Referral Hospital, in Eldoret Kenya, Riley Mother and Baby Hospital (RMBH) unit. RMBH is a public tertiary obstetric health-care center with an average of 12,000 deliveries annually. MTRH is the second largest referral hospital in Kenya.

Screening and Consent: Nulliparous women presenting to MTRH-RMBH with late or post-term pregnancy for scheduled induction of labor were considered for inclusion into the study. They were provided a comprehensive participant information sheet, with questions addressed by an available research assistant. Written informed consent was subsequently obtained from each participant.

Inclusion and Exclusion Criteria: Enrollment was restricted to nulliparous women (no prior pregnancy > 20 weeks' gestation), aged ≥ 18 years, at gestation age of 41+0 weeks or beyond-based on the last known monthly period, carrying a single live intrauterine pregnancy in cephalic presentation, with intact amniotic membranes, demonstrating a reassuring fetal heart rate pattern on cardiotocograph (CTG) tracing, non-significant contractions (two or more in 10 minutes), and an unfavorable cervix (Bishop score < 6). Women were excluded if they had a history of antepartum bleeding, use of another ripening agent before FC placement, active lower urinary tract infections, known or suspected latex allergy, placenta previa, significant fetal anomalies, contraindications to vaginal delivery, known or newly diagnosed Human Immunodeficiency Virus (HIV) infection.

Trial instrument was the silicone-coated latex 18 French gauge (Fg) Foley catheter, supplied by MTRH.

Randomization and Blinding: Randomization was computer-generated in random blocks of four. Opaque envelopes containing the group assignments were securely stored in the RMBH induction room within a locked box. Sealed, sequentially numbered opaque envelopes (SNOSE), each bearing a predetermined group allocation, were prepared by the trial statistician using an online block randomization tool (<https://www.sealedenvelope.com/simple-randomiser/v1/lists>), which produced a list of unique codes and corresponding group assignments. Participants were randomized by selecting an envelope in sequential order, each containing a card labeled with either the control arm indicator (FC inflated with 50-mL) or the intervention arm indicator (FC inflated with 80-mL).

The randomization envelope was opened solely by an unblinded nurse just prior to the placement of the intracervical extra-amniotic FC. The unblinded nurse also recorded the randomized code onto the data collection form. With the exception of the unblinded nurse and the Data Safety Monitoring Board (DSMB) members, the other parties involved in the study i.e. participants, midwives, the principal investigator, and outcome assessors, were

blinded to group assignments. The randomization codes key, linking participant identifiers and intervention groups, was held by the trial biostatistician.

Insertion of Foley catheter: After bladder emptying, participants were placed in the dorsal lithotomy position, the vulva was cleaned with chlorhexidine solution. The principal investigator (PI) assessed the Bishop score for all participants, then stepped out of the induction room. The cervix was exposed using a sterile speculum by an unblinded care provider, and a 20-Fr Foley catheter (Bardic Foley Catheter, Bard International, Inc.) was inserted into the extra-amniotic intracervical canal under direct visualization. Accurate placement of the catheter was confirmed above the internal os in the extra-amniotic space, and the balloon was inflated with sterile saline according to the participant's group allocation. Group 1 (control group) received a 50-ml inflation, while group 2 (intervention group) received an 80-mL inflation. The FC was not tapped nor tensioned.

Follow up assessment: Post-insertion, participants were encouraged to ambulate. Standard care including maternal assessment and fetal monitoring was applied to all participants. The FC was passively left in-situ for spontaneous expulsion. Post FC insertion, assessment of cervical Bishop score was conducted 24 hours after catheter placement by the PI.

Failed cervical ripening was defined as an unfavourable Bishop score after removal of FC with unfeasible amniotomy. As standard care, the healthcare provider would then counsel the participants regarding further management options. This included additional cervical ripening or proceeding with cesarean delivery if indicated.

Outcome measures: The primary endpoint was proportion of women achieving a Bishop score of ≥ 6 at 24 hours from catheter placement. The secondary outcomes included the proportion of vaginal deliveries within 24 hours from induction and the induction to delivery interval.

Data was captured using the data abstraction form and entered into an electronic database created using Microsoft Access.

Sample size calculations: The determination of sample size was based on work by Kara et al., (11) who found a 28% difference (60% vs 32%) in proportion of vaginal deliveries by 24 hours between the FC inflated with 80-mL versus 30-mL balloon volume. Using the OpenEpi sample size calculator (<https://www.openepi.com/SampleSize/SSMean.htm>) an alpha level of 0.05, power of 80%, 1:1 allocation ratio, 50 participants were required in each study arm. Sample size was increased by 20% to cater for drop out, resulting in a total 120 participants.

Statistical analysis: Data analysis was done using SPSS Statistics software (version 26, IBM Corporation, Chicago, IL). The Kolmogorov-Smirnov test was used to test for normality of continuous variables. Analysis of normally distributed continuous variables employed the Student's t-test, and the Mann-Whitney U test was used for skewed continuous or ordinal data. The Chi-square test was used for categorical variables, with the Fisher's exact test used when the chi-square test assumptions were not met. Significance was set at a $P < 0.05$. Treatment was analyzed according to the intention-to-treat principle.

RESULTS

From September 2021 through to September 2022, a total of 126 nulliparous women with late term pregnancy were screened for possible enrolment into the study. Three women were excluded from the study due to difficult insertion, 1 woman received prostaglandin for cervical ripening prior to the timing of Foley catheter insertion and 2 women declined to participate in the study, and 120 were randomized (Figure 1).

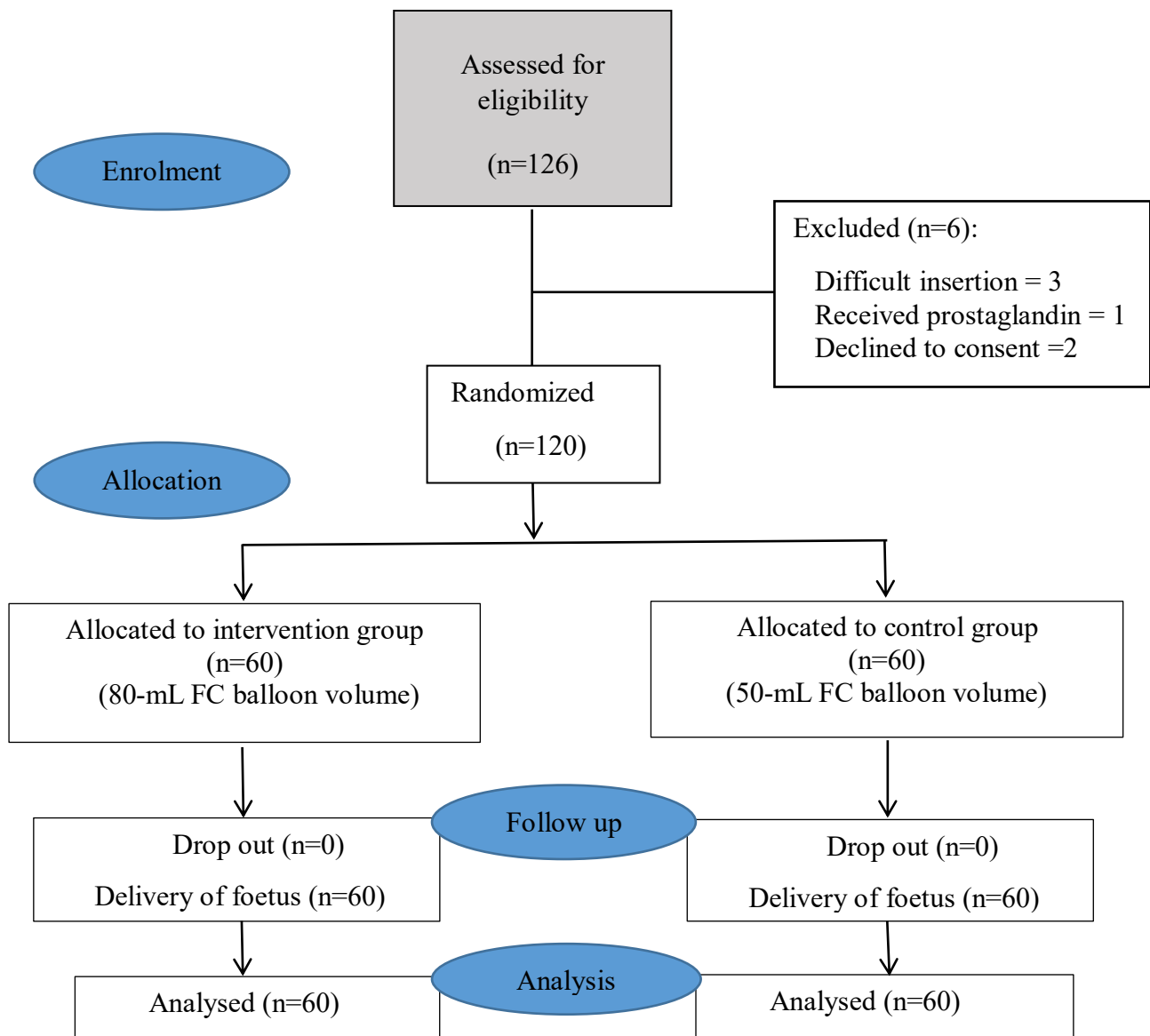


Figure 1: Participant's flow chart.

Baseline socio-demographic characteristics and pregnancy characteristics were comparable between study arms (Table 1).

Table 2:

Maternal demographic and pregnancy characteristics of 120 nulliparous women undergoing cervical ripening with transcervical Foley balloon catheter.

Maternal characteristics	50-mls Foley (n=60)	80-mls Foley (n=60)	Total	P
Maternal age (years)				
M±SD	26.6 ± 4	24.7 ± 4	25.8 ± 4.1	0.300 ^c
Occupation, n (%)				
Self-employed	21 (35%)	24 (40%)	45 (37.5%)	0.788 ^c
Employed	19 (31.7%)	14 (23.3%)	33 (27.5%)	
Unemployed	10 (16.7%)	11 (18.3%)	21 (17.5%)	
Student	10 (16.7%)	11 (18.3%)	21 (17.5%)	
Highest education, n (%)				
Primary	4 (6.7%)	8 (13.3%)	12 (10%)	0.451 ^c
Secondary	23 (38.3%)	23 (38.3%)	46 (38.3%)	
Tertiary	33 (55%)	29 (48.3%)	62 (51.7%)	
Marital status, n (%)				
Married	40 (66.7%)	44 (73.3%)	84 (70%)	0.426 ^c
Single	20 (33.3%)	16 (26.7%)	36 (30%)	
Antenatal care current pregnancy				
<4 times	12 (20%)	18 (30%)	30 (25%)	0.206 ^c
≥4 times	48 (80%)	42 (70%)	90 (75%)	
Medical comorbidities				
Absent	57 (95%)	59 (98.3%)	116 (96.7%)	0.619 ^f
Present	3 (5%)	1 (1.7%)	4 (3.3%)	
Gestational age (weeks)				
41	42 (70%)	40 (66.7%)	82 (68.3%)	0.502 ^f
42	17 (28.3%)	16 (26.7%)	33 (27.5%)	
43	1 (1.7%)	4 (6.7%)	5 (4.2%)	
Induction-to-delivery interval (h)				
M±SD	28.7 ±9.7	25.9 ±5.6	27.3 ±8	0.058 ^t
Foetal birth weight (g)				
M±SD	3312.6±388.4	3359.5±388.3	3336±387.4	0.510 ^t

c : Chi Square test

f : Fisher's Exact test

t: ttest

A higher percentage of women with FC inflated with 80-mL achieved a Bishop score of ≥ 6 at 24 hours compared to control group (90% versus 73.3%, OR 3.27 [1.18 – 9.06]).

Additionally, the need for additional cervical ripening with prostaglandins was also reduced in the intervention group (Table 2).

Table 2: *Change in Bishop Score and achievement of ≥ 6 Bishop score at 24 hours.*

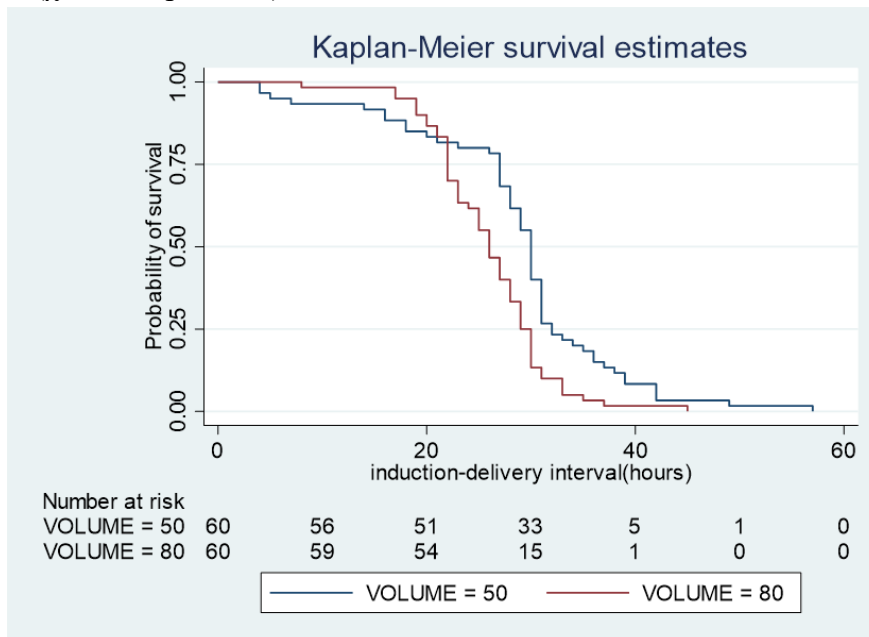
	Study group		Odds ratio	95% CI	P value
	50-mls Foley (n=60)	80-mls Foley (n=60)			
Bishop score ≥ 6 at 24hours n	44 (73.3%)	54 (90%)	3.273	1.18 – 9.07	0.023
Oxytocin Augmentation	56 (93.3%)	56 (93.3%)	1		>0.99
Additional ripening with prostaglandin	14 (23.3%)	5 (8.3%)	0.3	0.10 – 0.89	0.030

Data are presented as number (percentage).

The proportion of women who achieved vaginal deliveries within 24 hours, were comparable between study groups (88.3% versus 90%, $P = 0.769$)(Table 3).

Variable	Study group		Odds ratio	95% CI	P-Value
	50-mls Foley (n=60)	80-mls Foley (n=60)			
Delivery mode					
Caesarean delivery	6 (10%)	7 (11.7%)	1		
Vaginal delivery	54 (90%)	53 (88.3%)	0.84	0.27-2.67	0.769
Indication for caesarean delivery					
Arrest descent	2 (3.3%)	0			
Failed vacuum delivery	0	1 (1.7%)			
Failed IOL	1 (1.7%)	1 (1.7%)			
Protracted labour	1 (1.7%)	0			
Non-reassuring foetal status	2 (3.3%)	5 (8.3%)			

The Kaplan–Meir curve demonstrated a significant difference in the induction to delivery time for the two groups with the intervention group taking a shorter time to delivery ($\chi^2=12.2$, $p<0.001$).



DISCUSSION

On assessing the effects of intracervical FC balloon volume on cervical ripening, nulliparous women who received 80-mL FC balloon volume were over three times more likely to achieve a Bishop score of ≥ 6 at 24 hours post-insertion compared to those who received a 50-mL balloon volume. This was consistent with a US study that compared the efficacy of an 80-mL double-balloon catheter versus 30-mL single-balloon catheter,(12) a significant proportion of Bishop score ≥ 6 at the time of catheter removal was demonstrated with the larger balloon volume (OR18.8 [4.2–83.5]). The effectiveness of a larger volume catheter in promoting cervical ripening is underscored, potentially through increased separation of the amniotic membranes and subsequent prostaglandin release.

Salim, Raed et al., in comparing 80-mls double balloon FC to a 60-mls single-balloon FC for cervical ripening in Isreal, employed a 12-hour post-insertion removal time and found no significant difference in change in Bishop score between study groups(13). This highlights that the timing of catheter removal could be crucial, and that our study's 24-hour removal time may be conducive to observing the effect.

Use of 80-mL inflated FC balloon volume in nulliparous did not result in a significant difference in the rate of vaginal deliveries within 24 hours post-placement, compared with 50-mL FC volume. This is consistent with Sayed Ahmed, Waleed Ali, et al.'s findings in Egypt(14). Improvement in Bishop score with larger FC balloon volume may not independently correlate with an increase in the rate of vaginal deliveries within 24 hours. In

comparing an 80-ml double balloon with a 30-ml single balloon catheter, Levy et al.'s RCT in Israel(15), did find a significant increase in vaginal deliveries with the larger balloon (71.4% vs. 49.0%, $p=0.017$), possibly attributable to the more pronounced volume difference and a larger sample size.

The goal of induction is timely vaginal delivery. A shorter induction to delivery interval is associated with reduced costs and decreased risk of chorioamionitis (16). The study results suggest shorter induction to delivery intervals with larger FC balloon volume.

The FC is available, accessible, and relatively inexpensive. Considering its effectiveness, an 80-mL FC balloon volume for cervical ripening should be considered in for pre- induction cervical ripening in low-resource settings.

Study limitations: Women's satisfaction with the larger balloon volume was not assessed; however, no participants withdrew from the trial because of discomfort during or after FC insertion.

Conclusion: In late and post-term nulliparous women, pre-induction cervical ripening using transcervical FC with 80-mL balloon volume results in a higher proportion of women with favorable Bishop score at 24 hours and a shorter induction to delivery interval compared to 50-mL volume.

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