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ORIGINAL ARTICLE

The Art of Kielland rotational forceps delivery. Do we need more training or should we abandon it? That is the question: A retrospective observational study

Short title: The Art of Kielland Forceps

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ABSTRACT

Objective. There has been a wide variation in obstetric practice in the management of women at full cervical dilatation with malposition of foetal head, with many obstetricians preferring delivery by caesarean section over instrumental vaginal delivery. This could be attributed to the scarcity of published data about the safety and feasibility of Kielland's forceps as method of rotational operative vaginal delivery. This was a retrospective study from population-based registry that aimed to assess the potential benefits and harms imposed by Kielland's forceps in comparison to other methods used to assist mid-cavity rotational vaginal delivery, manual rotation and rotational vacuum extraction.

Patients and Methods. Seventy-two women, underwent rotational Kielland's forceps vaginal delivery in comparison to Sixty-nine women who had other rotational delivery: 42 rotational ventouse and 27 manual rotations, from October 2015 to October 2019 in the United Kingdom.

Results. The results showed 36.2% of the women had maternal complications. However, neither Kielland's forceps nor rotational ventouse exerted any significant effect on developing maternal complications compared to manual rotation (P=0.207 and 0.103 for Kielland's forceps and rotational ventouse respectively) with only one case of perinatal death in Kielland's forceps group. There were no maternal deaths, no thromboembolic events, and no laparotomies or hysterectomies in any of the three groups.

Conclusions. Kielland's forceps will remain a safe tool for rotation operative vaginal delivery. However, acknowledging and accepting the associating risks and complications, and obtaining an informed consent from pregnant women is essential before embarking on such procedure.

Key words

Foetal morbidity and mortality; maternal morbidity and mortality; rotational operative delivery.

Introduction

Since the introduction of Kielland's forceps in 1908 by Norwegian obstetrician Christian Kielland, there has been a lot of debate regarding its safety and feasibility as a method of rotational operative vaginal delivery in modern obstetrics. Kielland's forceps was originally designed for rotation and delivery of the foetal head, in either transverse or occiput posterior position.

Malposition of foetal head varies from 5%-12% of all births [1-3] and is the most common indication of second-stage caesarean section nowadays [4]. Although maternal morbidity is greater after second stage caesarean section than after successful instrumentation [5], there has been a major shift in the use of Kielland's forceps in favour of second stage caesarean section in past decade.

There is also a wide variation in obstetric practice in the management of women at full cervical dilatation with malposition of the foetal head. This could be due to the scarcity of published data on the outcome of rotational vaginal delivery in current literature, and/or wide range of opinions about the best mode of delivery. In 2009, a survey conducted by the Royal College of Obstetricians and Gynaecologists (RCOG) in the United Kingdom (UK) found that 8.8% of trainees would deliver women at full cervical dilatation with foetal malposition, at a station below ischial spines, by caesarean section rather than byu instrumental vaginal delivery [6]. In 2015, Bordahl reported that many obstetricians either discontinue or have never learnt to use rotational forceps [7].

This could be attributed to the poor reputation of Kielland's forceps, its perceived association with foetal and maternal morbidity and mortality, in addition to the major concerns about medical litigation. Furthermore, there were concerns about the effect of rotational forceps on foetal acid base balance and whether operative rotation of foetal head should only be attempted in the absence of foetal distress [8].

The aim of this study was to compare the potential benefits and harms of different methods used to assist mid-cavity rotational operative vaginal delivery.

Patients and Methods

This is a retrospective comparative study of seventy-two women who underwent Kielland's rotational vaginal delivery at East and North Hertfordshire NHS Trust, UK, from October 2015 to October 2019.

They were compared to Sixty-nine women who underwent mid-cavity rotational operative vaginal delivery, by other methods such as vacuum extractor or manually rotation followed by direct forceps application, by duty obstetrician and independent of authors.

The prerequisites for operative vaginal delivery were station of foetal head at, or 1 cm below the level of ischial spines, and the malposition of the foetal head, occiput-transverse, or

occiput-posterior position. In accordance with the local trust guidelines, all rotational operative vaginal deliveries were conducted in an operating theatre with informed and written consent from the patients, adequate anaesthesia, paediatric support, and with the immediate facility to convert to caesarean delivery if required.

The procedure of Kielland's forceps:

The anterior branch of the forceps is introduced along the guiding fingers and the blade is permitted to migrate anteriorly to the side of the baby's head. The blade is carried more anteriorly than in cephalic application of the classical forceps, so that they rest directly in front of the symphysis pubis. The posterior blade is inserted in the same manner. When the blades are in position, the rotation of the head is attempted before undertaking traction.

The procedure of rotational ventouse:

A suction cup is placed onto the head of the baby directly over the flexion point, about 3 cm anterior from the occipital (posterior) fontanelle. Rotation and traction usually occur at the same time during uterine contraction and active pushing of the mother.

The procedure of manual rotation:

The hand is inserted completely into the vagina and cradles the occiput in their whole hand. Gentle pressure is applied to the anterior fontanelle to generate flexion. The foetal head is then gently dis-impacted from the pelvis and rotated to occipito-anterior (OA), with the whole hand remaining around the foetal head.

A systematic review of medical records, electronic maternity and neonatal databases was performed to collect demographic and outcome data. The success rates, short-term maternal and neonatal outcomes were also collected and analysed. If any of delivery data was not available, the patient was not included in the study. Unsuccessful trials of labour were also excluded from the study.

The primary outcome of the study is the presence of maternal and neonatal complications during delivery. The exposure of interest is the type of instrument used for delivery, including Kielland forceps, rotational ventouse, and manual rotation. Other covariates included in the analysis are maternal predictors (age, BMI, parity), foetal predictors (foetal weight and gestational age), and delivery process predictors (onset of labour and number of pulls).

The statistical analysis was performed in two stages. The first stage of analysis involved examining the individual association of each exposure and covariate with the outcome using odds ratio for binary variables and point-biserial correlation for continuous variables after testing for its assumption. In the second stage of analysis, we examined the effect of using Kielland forceps on developing maternal complication after adjusting for other covariates in five nested subsequent logistic models.

The logistic models were used to estimate the odds ratio of having maternal complications associated with the use of Kielland forceps while adjusting for other covariates. The models were built in a stepwise manner, adding covariates in each subsequent model, and comparing the likelihood ratio tests between the models to assess the significance of adding each covariate. Statistical analysis was performed using the IBM SPSS Statistics for Windows, version 28.0.

Results

Over the study period, 141 patients, who underwent mid-cavity rotational vaginal delivery, were included in the study. Figure (1) shows mode of rotational operative delivery for study population and different indications.

The descriptive statistics show that about half of the sample delivered their foetuses using Kielland forceps while 28.6% delivered using rotational ventouse and the rest of the sample delivered using manual rotation. The average maternal age was 31 years, with over half of the sample having BMI above 24.9 and 38.3% were multiparous. More than half of the foetuses weighed above 3500gm and 48.9% had a gestation period of more than 40 weeks. More than 36% of the sample had maternal complications, 31.9% had primary postpartum haemorrhage, 4.3% had obstetric anal sphincter injury, and shoulder dystocia was present in four cases (2.8%). There were also 25 foetuses (17.7%) who were admitted to Special Care Baby Unit (SCBU), where 14 (9.9%) were admitted for observation and intravenous antibiotics because of maternal sepsis in labour, 3 (2.1 %) for phototherapy treatment, 6 (4.3%) for Transient Tachypnoea of New-born (TTN), one (0.7%) for prematurity and one (0.7%) foetus developed cervical cord injury in Kielland's rotational forceps group.

We started the analysis by examining the relationship between each risk factor and the outcome (developing maternal complications) individually. Then we performed a logistic regression model to control for all the potential risk factors. The key findings of examining each risk factors individually showed that age, parity, and BMI do not have any significant effect on the outcome. However, as shown in figure (2), being multiparous increases the likelihood of developing maternal complications when using rotational ventouse or manual rotation whereas for Kielland's forceps, there is a slight effect of being multiparous on maternal complication.

Regarding the effect of foetal weight, the results showed that higher foetal weight is a risk factor for maternal complications where 43.6% of mothers whose foetal weighed more than 3.5 kilograms developed maternal complications compared to 27% of mothers whose foetal weighed less than or equal 3.5 kilograms (Odds ratio= 2.091, 95%CI= [1.024, 4.27]). It is worth mentioning that the effect of foetal weight on developing maternal complication is highly dependent on the delivery method. The results showed that, for mothers who delivered using Kielland delivery, 52.5% of mothers whose foetuses weighed more than 3.5 kilograms developed maternal complications compared to 21.9% of mothers whose foetuses weighed less than or equal 3.5 kilograms resulting in an odds ratio of 3.947 (95%CI= [1.391, 11.2]). The corresponding figures are 32.3% and 33.3% for foetal weights <=3.5 Kilo grams and >3.5 kilo grams respectively using other methods of delivery (i.e. rotational ventouse or manual rotation) with an odds ratio very close to 1, meaning that foetal weight is not a risk factor of these non-Kielland's methods (95%CI= [0.398-2.992]). As shown in figure 3, Kielland's delivery appears safer than rotational ventouse and manual rotation in terms of decreasing the likelihood of developing maternal complications when foetal weight is less than or equal to 3.5 kilograms.

It was not possible to conduct an analysis on foetal complications, due to the lack of statistical power, as there was only one case of foetal complications in Kielland's forceps rotational group. There were no maternal deaths, thromboembolic events, or laparotomies or hysterectomies in any of three groups.

Modelling maternal complications

In examining the impact of using Kielland's delivery while controlling for the maternal, foetal, and delivery process characteristics on the odds of developing maternal complications, five

nested models were used. Each model is presented and examined for its significant contribution in explaining maternal complications. In order to show how the confidence in the relationships between the predictors and the outcome changes when we add more predictors to the model, we utilized three significance levels (0.1, 0.05, and 0.01) and indicated for each variable the level at which the relationship is considered significant.

Table (1) presents results of the logistic regression of developing maternal complications for five models. The predictors examined in these models are classified into five groups;

(1) Delivery method where effect of Kielland's delivery and Rotational Ventouse methods on developing maternal complication were examined compared to using manual rotation.

(2) Maternal characteristics (mother's age, BMI, and parity).

(3) Foetal characteristics (foetal weight and gestation period).

(4) Delivery process characteristics (onset of labours and number of pulls)

(5) The interaction effect of Kiellands delivery on the effect of multiparity and BMI on likelihood of developing maternal complication.

The impact of the delivery method on developing maternal complications was examined in model 1. The results showed that neither Kielland's forceps nor rotational ventouse exerted any significant effect on developing maternal complications compared to manual rotation. Model 1 was adjusted by controlling for the impact of maternal characteristics in model 2. The results showed that only multiparity increased the odds of developing maternal complications while other variables do not have any significant effect on the outcome. Model 2 was adjusted by removing age predictor as well as controlling for impact of foetal characteristics in model 3. The results of this model show that the only significant predictor is gestation period of >40 weeks which increases the likelihood of developing maternal complications by 2.793 times. (95% CI= [1.324,5.892]). The results showed that addition of foetal characteristics improves the ability of the model to predict the outcome from 61.7% to 68.1%. Adjusting the previous models by controlling for effect of delivery process characteristics in model 4 maintained direction and significant effects of predictors in model 3 and improved the model.

In model 5, the interaction effects of using Kielland's delivery for multiparous mothers and for mothers with BMI>24.9 were considered. The results of this model showed that multiparous mothers are about 7.5 times more likely to develop maternal complications than primiparous mothers (95%CI= [1.271,44.461]). However, using Kielland's forceps in the case of multiparous mother decreases the odds of developing maternal complication significantly as indicated by the odds ratio of 0.1 (95%CI=0.011, 0.890), suggesting the use of Kielland's forceps in the case of multiparous mothers to decrease the likelihood of developing maternal complication. In addition, the predictor's "foetal weight" becomes significant in model 5. The results show that mothers whose foetuses weighed more than 3500gm are about twice as likely to develop maternal complications than mothers with foetuses weighing less than or equal 3500gm. Other significant predictors are gestation period >40 weeks, which increases the odds of developing maternal complications by 3.105 times (95%CI= [1.419,6.793]). All other variables do not exert any significant impact on developing maternal complications.

The final model has an ability to predict 75.2% of maternal complications correctly indicating that the model does a good job in predicting the probability of developing maternal complication.

Discussion

The current study showed that careful use of Kielland's forceps was not associated with any more risks to women and their babies than is expected from any other method of rotational operative vaginal delivery. The study was primarily designed to study the outcome of Kielland's rotational forceps. However, it was compared to the outcome of other rotational methods to put its findings into context.

One advantage of the current study is the unawareness of operator of selected cases included in the study, hence minimizing any comparison or bias between different methods of rotational operative vaginal delivery. The present study also reported no significant difference in neonatal outcome whether indication for rotational operative delivery was failure to progress of labour or non-reassuring foetal heart trace.

Our results are consistent with Bahl et al. [9], who reported no significant difference between different methods of rotational operative vaginal delivery in maternal and neonatal outcome, though their study involved cohort of nulliparous women only. Moreover, we noticed that mothers who delivered using Kielland's delivery and whose foetuses weighed more than 3.5 Kilo grams, were about 4 times more likely to develop maternal complication than those who delivered using Kielland's and their foetuses weighed less than or equal 3.5 Kilo grams. This difference was not observed in the other two groups. This may be attributed to the risk imposed by forceps delivery that was compounded by the risk of high foetal birthweight, or it may be due to the smaller samples of rotational ventouse, and manual rotation compared with Kielland rotational forceps. However, it is unrealistic to perform systematic episiotomies during operative vaginal birth, as it would result in overtreatment and an unjustified increase of perineum morbidity [10].

In contrast to O'Brien findings [11], there was no significance difference in the risk of shoulder dystocia in the Kielland's forceps group, compared to the other two groups.

There was one reported case of cervical cord injury in the current study that resulted in an early neonatal death. This was a primigravida woman who was induced at 39 weeks after prolonged spontaneous rupture of membranes for more than 24 hours. Labour progressed well and the baby was found to be in right occiptoposterior position in the second stage of labour. The baby was born in a very poor condition with cord blood gases of 7.343 and 7.184. The baby was diagnosed with hypoxic ischemic encephalopathy, intubated and transferred to Great Ormond Street Hospital in London for cooling, where he later dies as a result of cervical cord injury. This is recognized serious complication of rotational vaginal delivery with Kielland's forceps. Nevertheless, it was not part of the local hospital consent form and was not included in the RCOG consent advice of operative vaginal delivery [12]. This is the third published case of early neonatal death in UK in last 10 years, after Kielland's forceps application [13-14]. Using Kielland's forceps safely requires high level of skills and expertise, though the outcome is almost always uncertain even with the right experienced hands. As in the current study, other two reported cases of neonatal deaths were performed by very experienced obstetricians that performed successful Kielland's forceps before and after the incident. In recent systematic review, Wattar et al. reported 0.3% perinatal mortality rate associated with use of Kielland's forceps, though he attributed reported deaths to other factors such as congenital abnormalities, intrapartum asphyxia, and prematurity [15]. This may explain why Bertholdt et al., in 2022, advocated use of instrumental rotation with either vacuum or forceps only after manual rotation failure [16].

It is difficult to explain the exact reasons of perinatal deaths in such cases. One explanation might be the rotation of foetal head in a direction opposite to foetal body, causing the

sheering and injury of the cervical cord. Another explanation might be that such injury is inflicted by trauma caused by the excessive rotation and traction of the foetal head, causing the dissection of the carotid arteries. The third explanation might be undiagnosed foetal musculoskeletal anomaly. The need for training and structured discussion meetings, in any case, is important. Clinical audits compared to individual revision of clinical cases alone or to unstructured meetings between operators, are certainly more productive [17].

Instrumental rotational deliveries, in general, involve highly-skilled manipulation that is difficult and time-consuming to teach and learn. With caesarean sections, you can see exactly what the person is doing, while with forceps, there is feel that is very hard to teach. Unfortunately, such training is very unlikely nowadays with fewer working hours for junior doctors. This may explain in part, the current tendency for earlier resource to caesarean section with the malposition of the foetal head among junior doctors.

The American College of Obstetricians and Gynaecologists (ACOG) supports the use of Kielland's forceps and directs practitioners to select a strategy based on their own experiences and skills [18]. On the other side of the sea, the Royal College of Obstetricians and Gynaecologists (RCOG) recommends that obstetricians should be confident and competent in a minimum of one technique of rotational delivery [19]. Nevertheless, a declining trend in the use of Kielland's forceps is very considerable. Training and experience are important influences on clinical behaviour, and it would be expected that as these increase the confidence to manage complicated labour and delivery would also increase. Ultrasound assessment of foetal position may be helpful for new operators [20]. The opposite could also apply, promoting earlier recourse to caesarean section [21]. However, caesarean section is a major abdominal surgery, which should not be chosen lightly, and is certainly of no benefit to the mother in most instances.

On the other hand, most cases in which the foetus was found to be in a transverse position were attributable to a failure to rotate, generally as a result of an epidural block that had altered the muscular component of the rotational mechanism. This would be associated with a rise in rotational operative vaginal delivery [22]. Even at low concentrations, there is no sufficient evidence to confirm or refute that low doses of epidural analgesia would not increase the risk of instrumental delivery.

The art of obstetrics does not only involve the judicious use of Kielland's forceps when performing complex operative vaginal deliveries, but, more importantly, it entails the knowledge and capacity of when to abandon the procedure [23]. However, we must acknowledge that there will always be vaginal deliveries that can progress to a stage where rotational operative delivery would be the safer option than complicated caesarean sections. The understanding of women with regards to specific foetal risks such as foetal macrosomia and intrauterine foetal death was positively affected by a high level of education and having had previous pregnancies [24]. Workshops for rotational and non-rotational, operative vaginal delivery, should be incorporated in early years of training at registrar level rather than be left to the final years of training. Training would ideally begin in a supervised simulation setting with strong emphasis on both technical and non-technical skills [25]. Widespread re-introduction of rotational forceps delivery would be challenging and would depend on the program of training and support by obstetricians experienced in rotational delivery [26].

Randomised controlled trials of rotational operative vaginal delivery versus caesarean section at full cervical dilatation is very unlikely to abide with the current ethical standards of research studies. The main reason would be that women, who can achieve vaginal delivery by skilled obstetrician, might be allocated to caesarean section arm with its known short and long-term morbidities and mortalities for the sole purpose of study. In addition, to recruit

women to studies while they are in labour is thought to be unethical, and recruitment in antenatal period could result in women becoming distressed at the possibility of obstructed labour, when only few women (4%) are usually affected [5]. It is not possible to study every clinical outcome with a randomised trial. Multiple, independent cohort studies may be ‘’ good enough’’ to justify adding/omitting the new surgery to/from our armamentarium [27].

A current multi-centre study also comparing manual to instrumental rotational techniques- the ROTATE trial is currently underway in the UK. Results of this study are eagerly awaited but recruitment is yet to commence.

Though number of patients in the current study is relatively small to formalize statistically significant differences, we believe that the results are still valid and provide further evidence in support of rotational operative vaginal delivery in view of paucity of publication in this subject. Another imitation of current study is that it did not report on the long-term outcome of rotational operative deliveries on maternal and foetal wellbeing.

Conclusions

The question that remains to be answered is whether Kielland’s forceps is a safe tool that needs more training or whether it is dangerous tool that should be abandoned. Acknowledging and accepting the risks and complications associated with rotational operative delivery using Kielland’s forceps, and obtaining an informed valid consent is essential pre-requisite before usage of Kielland’s forceps for rotation and delivery of head malposition. Collaboration and sharing of data between different trusts worldwide is necessary to formulate an evidence-based approach.

Authors Contribution

MMH contributed to the design of the study, data collection and drafted the original manuscript.

SI contributed to the concept and design of the study and data collection.

HG contributed to the data analysis, interpretation and curation.

HM contributed to the editing and revision of the final draft of the study.

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Disclosure of Interest

None

Ethical Approval

Data of operative vaginal delivery data were collected during routine clinical practice, and analysis of data was retrospective. Thus our study did not require approval from the institutional review board.

Informed Consent

Not required as the data were collected during routine clinical practice.

Data Sharing

Data of the study is available on request from the authors.

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Table 1: Logistic regression models' results

	Model 1		Model 2		Model 3		Model 4		Model 5	
	exp(B)	S.E	exp(B)	S.E	exp(B)	S.E	exp(B)	S.E	exp(B)	S.E
Constant	0.5*	0.408	1.182	1.158	0.156***	0.595	0.204**	0.689	0.136	0.773
Method of delivery										
X_1: Kielland	1.273	0.474	1.181	0.484	1.228	0.5	1.127	0.507	2.457	0.712
X_2: Rotational	1.0	0.523	0.672	0.618	0.637	0.632	0.627	0.630	0.228	0.908
Maternal predictors										
X_3: Age			0.966	0.035	---	---	---	---	---	---
X_4: BMI>24.9			1.134	0.360	1.382	0.381	1.336	0.390	1.801	0.586
X_5: Multiparous			2.082*	0.441	2.035	0.463	1.88	0.473	7.517**	0.907
Fetal predictors										
X_6: Fetal weight					1.749	0.385	1.756	0.388	1.963*	0.403
X_7: Gestation					2.793***	0.381	3.004***	0.388	3.105***	0.399
Delivery process										
X_8: Onset of							1.050	0.381	1.197	0.394
X_9: Number of							0.717	0.406	0.606	0.424
X_{10}: Number of							0.221	0.891	0.280	0.901
Interaction effects										
X_{11}: Kielland									0.1**	1.116
X_{12}: Kielland									0.512	0.784
Percentage of	63.8%		61.7%		68.1%		68.8%		75.2%	

Key: *** significant at 0.01, **significant at 0.05, * significant at 0.1

Figure (1): Modes and indications of rotational operative vaginal delivery for the study population.

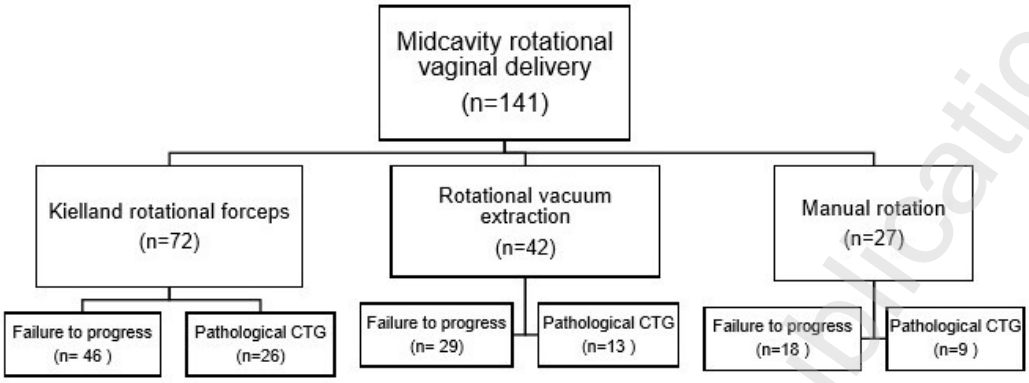

Figure (2): The interaction effect of parity and delivery method on maternal complications.

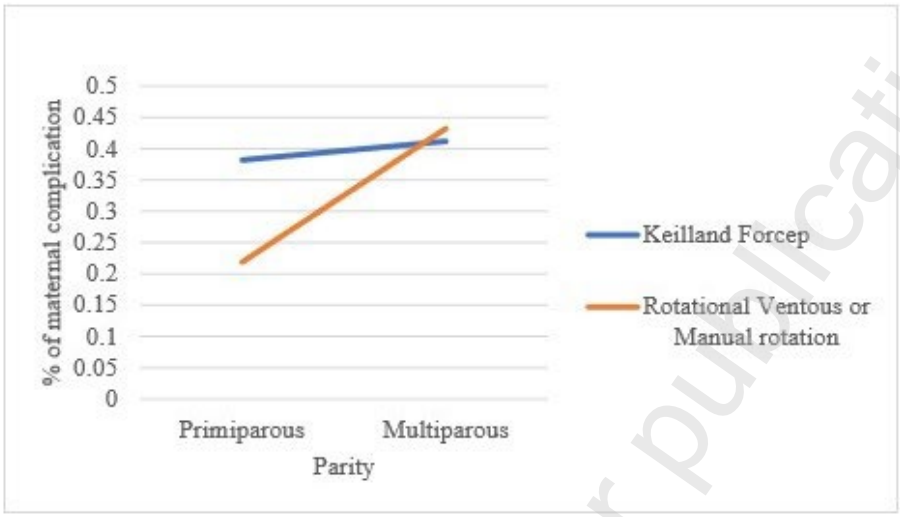

Figure (3): The interaction of foetal weight and method of delivery on maternal complications in rotational operative vaginal delivery groups.