The French Ambulatory Cesarean Section: Safety and Recovery Characteristics

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ABSTRACT

Objectives: The French AmbUlatory Extraperitoneal Cesarean Section (FAUCS) is aimed at improving patients' birth experience and recovery. However, data are scarce regarding its maternal and neonatal safety. This study seeks to compare maternal and neonatal outcomes between FAUCS and conventional cesarean deliveries at term.

Methods: This was a retrospective cohort study involving women who underwent scheduled cesarean deliveries at term. We compared a total of 810 cases using the FAUCS technique with 217 cases using conventional cesarean deliveries. Surgical complications, adverse neonatal events, and maternal recovery parameters were compared.

Results: The incidence of overall surgical complications was comparable between the 2 groups, with rates of 1.97% for FAUCS and 1.85% for the conventional cesarean deliveries. The rates of specific complications such as bladder injury (0.1%), bowel injury (0.1%), blood transfusion (1.35%), and postpartum hemorrhage (1%) were consistent with existing literature. Neonatal outcomes, including neonatal acidemia and admission rates to the neonatal intensive care unit, were comparable between the groups and demonstrated favourable comparisons with previously reported data. Notably, women in the FAUCS group required less analgesia, with only 0.8% receiving morphine, as opposed to 38% in the control group. Furthermore, the FAUCS group demonstrated significantly quicker recovery, with 86% achieving autonomy and early discharge at their discretion within 48 hours after operation, in contrast to only 17% in the control group.

Conclusions: When performed by experienced practitioners, FAUCS proves to be a safe procedure, with no increased risk for maternal or neonatal complications. Its significant benefits in terms of enhancing maternal recovery are noteworthy.

Keywords: cesarean delivery; enhanced recovery after cesarean; French AmbUlatory Cesarean Section; FAUCS; postoperative complications

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RÉSUMÉ

Objectif : La césarienne extrapéritonéale (ou FAUCS, de l'anglais *French AmbUlatory Extraperitoneal Cesarean Section*) vise l'amélioration de l'expérience d'accouchement et du rétablissement. Cependant, il y a très peu de données sur l'innocuité maternelle et néonatale de l'intervention. Cette étude vise à comparer les issues maternelles et néonatales entre la FAUCS et la césarienne traditionnelle à terme.

Méthode : Étude de cohorte rétrospective portant sur des femmes ayant subi une césarienne programmée à terme. Nous avons comparé un total de 810 cas exécutés par la technique FAUCS avec 217 cas par césarienne traditionnelle. Les complications chirurgicales, les événements indésirables néonataux et les paramètres de rétablissement maternel ont été comparés.

Résultats : L'incidence globale des complications chirurgicales était comparable entre les deux groupes, avec des taux de 1,97 % pour les FAUCS et de 1,85 % pour les césariennes traditionnelles. Les complications précises telles que les lésions de la vessie (0,1 %), les lésions de l'intestin (0,1 %), les transfusions sanguines (1,35 %) et les hémorragies post-partum (1 %) concordent avec la littérature existante. Les issues néonatales, y compris l'acidémie néonatale et l'admission aux soins intensifs néonataux, étaient comparables entre les groupes, et les comparaisons aux données précédemment rapportées sont comparables. Notamment, les femmes du groupe FAUCS ont eu besoin de moins d'analgésie, puisque seulement 0,8 % ont reçu de la morphine comparativement à 38 % dans le groupe témoin. De plus, les femmes du groupe FAUCS se sont rétablies beaucoup plus rapidement : 86 % étaient autonomes et ont pu avoir leur congé d'hôpital à leur guise dans les 48 heures suivant l'opération comparativement à 17 % dans le groupe de césarienne traditionnelle.

Conclusion : Entre des mains expérimentées, la FAUCS s'avère une intervention sûre, sans augmentation du risque de complications maternelles ou néonatales. Les avantages significatifs de l'intervention en matière de rétablissement maternel sont notables.

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INTRODUCTION

Cesarean delivery (CD) rates are on the rise globally, encompassing over 21% of all births today[1] and projected to surpass 29% by 2030,[2] with the United States already at 32.1% by 2021.[3]

Conventional CD[4,5] (CCD) is widely recognized as a safe and effective procedure.[6] However, known postpartum challenges, including significant pain, maternal impairment, and the risk of chronic pain and depression[7] might impede mother−child bonding.

The French AmbUlatory Extraperitoneal Cesarean Section (FAUCS) aims to improve patient recovery by minimizing tissue trauma and preserving biological functions.[8,9] FAUCS practitioners have reported enhanced patient recovery, earlier autonomy, and reduced analgesic requirements,[10] facilitating immediate postpartum bonding. Notably, FAUCS differs from CCD in key surgical techniques (described in Supplement 1, online Appendix).

Comprehensive data on postoperative complications of FAUCS compared with CCD are limited. Our retrospective cohort study examines adverse maternal and neonatal outcomes, assessing the short-term safety profile and potential benefits of FAUCS, such as reduced hospital stays and analgesic use.

METHODS

Study Design and Participants

This retrospective cohort study involved scheduled CDs at term, using either the FAUCS technique or CCD. Procedures were conducted by senior experienced surgeons at a single medical centre from April 2018 to May 2022, with data sourced from the electronic medical database.

Inclusion and Exclusion Criteria

The study included scheduled term (37^0−42^0 weeks gestation) CD, excluding non-elective cases, operations performed by residents, and instances of placenta accreta.

Surgical Techniques

FAUCS followed the technique described and illustrated by Ami et al.,[8] complemented with rectus muscle approximation, while CCD adhered to the method outlined by Holmgren et al.[11] FAUCS procedures were performed by I.H., while CCD was conducted by 2 other certified senior obstetrics and gynaecology surgeons. Detailed techniques are provided in Supplement 1 (online Appendix).

Anaesthesia and Analgesia

Spinal anaesthesia in the study group consisted of 2 mL of 7 to 10 mg ropivacaine, as opposed to 8 to 11 mg in the control group, along with 0.5 mL (10−25 μg) fentanyl. Initial analgesia for the first 24 hours included 400 mg ibuprofen orally, 1 g paracetamol intravenously, and 1 g dipyrone orally, systematically administered every 6 hours for FAUCS, and on demand for CCD. Additional analgesia and/or morphine was provided on demand.

Population Differences

The FAUCS patient population comprised individuals from diverse regions. CD indications were either determined by another medical team or based on the patient's request, made on the basis of perceived benefits. The control group consisted solely of local patients undergoing surgery based on common indications, resulting in a significantly larger study group with distinct basic characteristics compared with the control group.

Key Differences between CCD and FAUCS

CCD involved bladder catheterization. This is omitted in FAUCS because bladder catheterization may not be necessary if the patient has urinated independently before surgery, improving anatomical visibility and minimizing bladder damage risks. Fetal extraction during FAUCS was performed using Tessier spatulas for safe head navigation. FAUCS promoted active maternal participation through the use of a mouthpiece device (Winner Flow; STIMED), immediate skin-to-skin contact, and encouragement for breastfeeding. Skin closure methods also differed, with FAUCS using Dermabond glue (Ethicon) and CCD using INSORB subcuticular absorbed staples (CooperSurgical). Additionally, FAUCS was conducted in a private health care setting, while CCD procedures were performed within the public health care system.

Outcomes and Analysis

Primary outcomes included maternal surgical complication rates (e.g., bladder or bowel injury, postpartum hemorrhage, blood transfusion, relaparotomy) and neonatal complications (e.g., cord pH <7.2, Apgar score <7 at 10

minutes, neonatal intensive care unit [NICU] hospitalization, fetal injury). Secondary outcomes encompassed duration of operation, the time from skin incision to fetal extraction, changes in hemoglobin levels, analgesic requirements beyond the initial 24 hours, and length of hospital stay. A comparative analysis of adverse outcomes between the 2 groups was conducted using appropriate statistical tests, such as analysis of variance, χ^2 test, Fisher exact test, and logistic regression, as applicable.

To adjust for the non-comparability of the FAUCS and CCD groups, we used a simple linear regression test and a non-linear random forest machine learning model (data not shown). Both methods confirmed that the statistical differences found between the groups persisted when a non-linear correlation was allowed between the operation's properties and the operation's type and outcome. Statistical significance was set at $P < 0.05$. IBM SPSS Statistics, Version 27.0 software (IBM Corp.) was used for all analyses, and the study received ethical approval from the local hospital committee. Informed consent was waived because of minimal risk to the participants, as defined in Title 21 of the Code of Federal Regulations (21 CFR 50.3[k] or 56.102[i]).

RESULTS

Comparison Between Groups

A total of 2788 CDs were performed between 1 April 2018 and 31 May 2022. Out of these, 1027 CDs were included in the analysis: 810 using the FAUCS technique and 217 using the CCD method (Figure). Maternal characteristics are summarized in Table 1. Notably, women in the FAUCS group had a higher median age (35 years) compared with those in the CCD group (30 years), and a larger proportion (42%) underwent their first CD compared with the CCD group (26%).

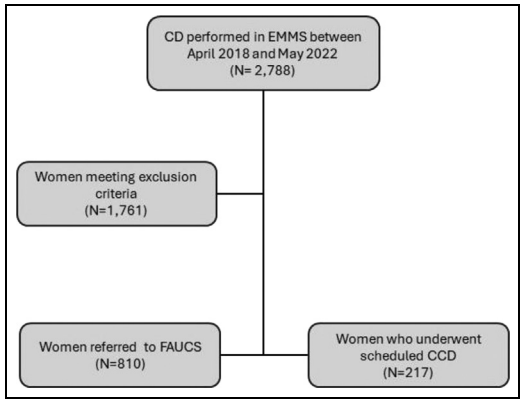
Surgical Outcomes

The FAUCS procedure took longer compared with CCD (49 vs. 45 minutes, $P < 0.001$), yet the time from skin incision to delivery was shorter with FAUCS (8.0 vs. 9.0 minutes, $P = 0.02$). Rates of surgical complications (Table 2) did not significantly differ between the FAUCS and CCD groups (1.97% vs. 1.84%, $P > 0.9$). Likewise, there were no significant variances in the rates of hemoglobin decline >3 g/dL (3.1% in FAUCS vs. 1.9% in CCD, $P = 0.3$) or the need for blood transfusion (1.35% in FAUCS vs. 1.4% in CCD, $P > 0.9$).

Neonatal Outcomes

Neonatal outcomes, including Apgar scores at 1 and 10 minutes below 7 (Table 2), showed no differences between groups. Median umbilical cord pH was slightly higher in the FAUCS group (7.33 [IQR 7.26–7.37] vs. 7.32 [IQR 7.27–7.35], $P = 0.008$). However, there were no variations between the groups in the rates of pH values <7.2 at 10%, <7.1 at 1.0%, and <7.0 at 0.1%. In the FAUCS group, mild transient neonatal injuries occurred in 7 cases (0.8%), including clavicular fracture, skin laceration, ping-pong fracture, cephalic hematoma, transient Erb's palsy, and 1 femoral fracture.

Figure. Patient flowchart.



Retrospective comparison of women undergoing FAUCS versus CCD. Inclusion: CDs performed between 37^0 and 42^0 weeks gestation. Exclusion: non-elective CDs (urgent or emergent cases), surgeries conducted by residents, and placenta accreta. CCD: conventional cesarean delivery; CD: cesarean delivery; EMMS: Nazareth Hospital EMMS; FAUCS: French AmbUlatory Cesarean Section.

Maternal Recovery and Autonomy

Women undergoing FAUCS experienced less pain during hospitalization and achieved autonomy more quickly (Table 3). The FAUCS group had a significantly shorter median time to mobilization compared with the CCD group (3.50 vs. 8.00 hours, $P < 0.001$). They also required fewer analgesics beyond the initial 24 hours, with a lower rate of morphine requests due to pain intensity (0.7% vs. 38% in the CCD group, $P < 0.001$). Moreover, the FAUCS procedure resulted in shorter hospital stays, with over 85.7% of women discharged within 2 days at their discretion, as opposed to 17% in the CCD group ($P < 0.001$).

DISCUSSION

Principal Findings

While FAUCS has shown promise in improving patient recovery,[10] concerns persist among obstetricians regarding maternal and neonatal safety. In our cohort study, we evaluated the safety of FAUCS compared with CCD. Analyzing 810 FAUCS and 217 CCD cases involving

Table 1. Patient main obstetrical and demographic characteristics

Characteristics	FAUCS (n = 810)	CCD (n = 217)	*P* value[a]
Maternal age (y)[b]	35.0 (32.0–38.0)	30.0 (27.0–33.0)	<0.001[c]
Gestational age at delivery (wk)[b]	38^{1} (38^{0}–38^{5})	38^{0} (38^{0}–39^{0})	0.8
Number of fetuses[d]			0.015
One	780 (96)	206 (95)	
Two	30 (3.7)	8 (3.7)	
Three	0 (0)	3 (1.4)	
Parity category[d]			<0.001[c]
None	111 cases (14)	22 cases (10)	
1	286 cases (35)	47 cases (22)	
2	254 cases (31)	73 cases (34)	
3	107 cases (13)	44 cases (20)	
4 and above	52 (6.4)	31 (14)	
Number of previous CDs[d]			<0.001[c]
None	341 (42)	56 (26)	
1	266 (33)	68 (31)	
2	161 (20)	68 (31)	
3 or more	42 (5.2)	25 (12)	
Indication for CD[d]			
Previous CD	416 (54)	152 (73)	
Maternal request	127 (16)	4 (1.9)	
Multiple gestation	19 (2.5)	9 (4.3)	
Fetal malpresentation	70 (9)	20 (9.6)	
Low placenta/placenta previa/vasa previa	13 (1.7)	2 (1)	
Inverted T or classical incision	1 (0.1)	0 (0)	
Other[e]	130 (16)	19 (8.7)	
Multiple indications	34 (4.4)	11 (5.3)	

[a]Wilcoxon rank sum test; Pearson χ^2 test; Fisher exact test.

[b]Median (IQR).

[c]There were statistically significant differences between the groups.

[d]n (%).

[e]History of third- or fourth-degree tears, traumatic instrumental delivery, suspected macrosomia, or myomectomy, maternal short stature, intrauterine growth restriction, or orthopaedic indications.

CCD: conventional cesarean delivery; CD: cesarean delivery; FAUCS: French AmbUlatory Cesarean Section.

scheduled term CDs, we found no differences in the rates of maternal surgical complications or adverse neonatal outcomes.

Results

Despite notable differences in maternal age, parity, number of previous CDs, and birth weight between the groups (Table 1), a univariate regression analysis was conducted to account for these variations and their potential impact on outcomes. Importantly, the type of surgery performed did not impact any outcomes. Instead, surgical complications correlated with procedure duration and a reduction in hemoglobin levels exceeding 3 g/dL. Fetal acidemia, conversely, was associated with the time elapsed between skin incision and delivery, gestational age, and maternal age (Supplement 2, online Appendix).

The FAUCS procedure had a slightly longer overall duration compared with CCD. However, the median time from skin incision to delivery was shorter with FAUCS (8.0 [6.0–10.0] vs. 9.0 minutes [6.0–12.0], respectively, $P = 0.02$) (Table 2), consistent with previous research. For reference, in a study of 21 372 women undergoing CD, Girsen et al.[12] reported a mean skin incision to delivery interval ranging from 9 to 18 minutes.

In the FAUCS group, we observed a 1.9% (n = 15) incidence of surgical complications, including 8 cases of postpartum hemorrhage (1.0%), 1 bladder injury (0.12%), 1 bowel injury (0.12%, due to bowel fistula found a week later in an extraperitoneal surgery with history of severe adhesions from 3 previous CCDs), 3 cases of uterine extension (0.37%), and 2 relaparotomies (due to uterine

Table 2. Surgical, maternal, and neonatal outcomes

Characteristics	FAUCS (n = 810)	CCD (n = 217)	*P* value[a]
Length of operation (min)[b]	49 (43–56)	45 (34–55)	<0.001[c]
Unknown	3	0	
Skin incision to delivery interval (min)[b]	8.0 (6.0–10.0)	9.0 (6.0–12.0)	0.022[c]
Unknown	3	0	
Maternal surgical complications[d]	16 (1.97)	4 (1.84)	>0.9
Blood transfusion[d]	11 (1.35)	3 (1.4)	>0.9
Birth weight[b]	3143 (2886–3414)	3248 (2988–3609)	<0.001[c]
Macrosomia (≥4000 g)[d]	26 (3.2)	12 (5.5)	0.1
Umbilical cord pH[b]	7.33 (7.26–7.37)	7.32 (7.27–7.35)	0.008[c]
pH <7.20[d]	83 (10)	23 (11)	0.9
pH <7.00[d]	1 (0.1)	2 (0.9)	0.11
Unknown	18	6	
Apgar[d]			
1 min <7	11 (1.4)	2 (0.9)	>0.9
10 min <7	0 (0)	0 (0)	>0.9
Neonatal complications			0.05
No complications[d]	779 (97)	206 (95)	
Unknown	8	0	
Neonatal injury[d]	7 (0.8)	0 (0)	
Neonatal NICU admission[d]	18 (2.1)	11 (5.1)	
Unknown	4	2	

[a]Wilcoxon rank sum test; Pearson χ^2 test; Fisher exact test.

[b]Median (IQR).

[c]There were statistically significant differences between the groups.

[d]n (%).

CCD: conventional cesarean delivery; FAUCS: French AmbUlatory Cesarean Section; NICU: neonatal intensive care unit.

artery branch bleeding and to rectus muscle bleeding). Additionally, the rate of blood transfusion was 1.35%. These findings align with previous research by Landon et al.,[13] who reported rates of 0.3% for bladder and bowel injury and 1% for blood transfusion in a cohort of 15 801 women undergoing scheduled CD. Our study's relaparotomy rate of 0.25% in the FAUCS group is consistent with rates described in 3 other studies.[14–16] Sagi et al.[17] recently conducted a double-blind randomised controlled trial comparing a modified version of intraperitoneal FAUCS with CCD (n = 58), reporting a higher rate of surgical complications at 8.3%, although this does not represent classic FAUCS rates because of their modifications in the surgical technique.

Neonatal outcomes (Table 2) in the FAUCS group included rates of pH <7.2 at 10%, pH <7.1 at 1.0%, and pH <7.0 at 0.1%, consistent with literature and comparable to scheduled CCD rates. Roberts et al.[18] reported rates of 18%, 3%, and 1% for pH <7.2, <7.1, and <7.0, respectively. Similarly, Rimsza et al.[19] found rates of 10%, 2.8%, and 1.1%, while Bligard et al.[20] reported a pH <7.2 rate of 12.1%. In the FAUCS group, 2.1% of neonates required NICU admission, as opposed to 5.1% in the CCD group (Table 2). Thomas et al.[21] reported a NICU admission rate of 6.3% among 1466 neonates born via scheduled CD at ≥37.0 weeks gestation. Similarly, Ahimbisibwe et al.[22] documented a 3.15% NICU admission rate for infants born by elective CD during a 4-year period in London, Ontario.

In our FAUCS group, we observed 7 cases (0.86%) of transient neonatal injury. Among these, 5 were linked to breech delivery, including femur fracture (occurred during internal manoeuvres to deliver the first of twins, with a distorted club foot stuck in the uterine fundus), thigh skin laceration, 2 Erb's palsies (occurring during traction to remove breech infants; since then, the method has changed to uterine pressure that pushes the head out, while the mouth and nose are outside of the incision,

Table 3. Maternal recovery and autonomy

Characteristics	FAUCS (n = 810)	CCD (n = 217)	*P* value[a]
Interval to mobilisation (h)[b]	3.50 (3.00–4.05)	8.00 (5.49–9.53)	<0.001[c]
Unknown	76	2	
Requested analgesia after first 24 h[d]			<0.001[c]
None	197 (24)	28 (13)	
Once	236 (30)	49 (23)	
Twice	198 (24)	43 (20)	
Thrice	99 (12)	38 (18)	
4 or more	70 (8.6)	59 (27)	
Morphine administered[d]	6 (0.7)	82 (38)	<0.001[c]
Duration of hospitalisation (d)[d]			<0.001[c]
1	38 (4.7)	0 (0)	
2	660 (81)	37 (17)	
3	74 (9.1)	93 (43)	
4	20 (2.5)	76 (35)	
>5	18 (2.2)	11 (5.1)	

[a]Wilcoxon rank sum test; Pearson χ^2 test; Fisher exact test.

[b]Median (IQR).

[c]There were statistically significant differences between the groups.

[d]n (%).

CCD: conventional cesarean delivery; FAUCS: French AmbUlatory Cesarean Section.

ensuring a free airway), and a cephalic hematoma. The remaining 2 cases were associated with vertex delivery: clavicular fracture and ping-pong fracture of the parietal bone. These injuries resolved spontaneously without long-term effects. Alexander et al.[23] reported a similar rate of fetal injuries (1.1%) in their study of 37 110 CDs.

Only 8% of the study participants received 4 or more doses of oral analgesics after the initial 24 hours, as opposed to 28% in the CCD group. Similarly, only 0.7% of the study population received morphine during hospitalization, contrasting with 38% of the CCD group. In other studies,[24–27] opioid use was significantly higher than our findings. Additionally, 86% of women in the FAUCS group were discharged at their discretion within 48 hours, contrasting with 17% in the CCD group. In a study by Teigen et al.[28] examining the impact of the Enhanced Recovery After Cesarean (ERAC) protocol, only 8.6% were discharged on postoperative day 2.

Strengths and Limitations

We recognize limitations in comparing our data with a smaller CCD control group, characterized by key differences. To address these disparities, we used a random forest model and conducted a thorough comparison with an extensive body of peer-reviewed literature. Importantly, our study's strengths lie in the substantial size of the group who underwent FAUCS, which strictly adhered to the original technique.

CONCLUSIONS

Our study confirms the safety of scheduled FAUCS at term, showing no increased risk of maternal or neonatal complications. Furthermore, FAUCS may provide advantages in maternal recovery and mother–child bonding.

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ETHICS

EMMS Nazereth research ethics board approval number 38-21-EMMS/ 10-march-2022.

DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT-3.5 for language editing. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jogc.2024.102606.

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