Implementation of French AmbUlatory Cesarean Section (FAUCS): Establishment of a Learning Curve and Short-term Outcomes

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ABSTRACT **Background:** The French AmbUlatory Cesarean Section (FAUCS) technique was introduced to the Galilee Medical Center in September 2021. FAUCS was performed electively for interested women who meet the criteria.

Objectives: To evaluate the learning curve of senior surgeons performing FAUCS, the procedure short-term outcomes, and complications.

Methods: This retrospective study included 50 consecutive women who underwent FAUCS from September 2021 until March 2022 at our facility. Preoperative, intraoperative, postoperative, and demographic data were retrieved from patient electronic charts.

Results: The mean age was 34.2 ± 5.6 years. The mean duration of surgery was 53.26 ± 11.62 minutes. This time decreased as the surgical team's experience increased: from a mean 58.26 ± 12.25 minutes for the first 15 procedures to a mean 51.17 ± 9.73 minutes for subsequent procedures. The mean visual analogue scale score for 24 hours was 1.08 ± 0.84 (on a 10-point scale). The mean time to spontaneous urination after the operation was 6.23 ± 3.73 hours; 44% of the women were able to mobilize and urinate spontaneously by 4–6 hours. Complications included bladder injury (n=1), endometritis (n=1), and incisional hematoma (n=1). Overall, the maternal satisfaction rate was high; 94% of the women would recommend FAUCS to others.

Conclusions: FAUCS is a feasible procedure with a high satisfaction rate. Following the first 15 procedures performed by one surgical team, the operative time decreased considerably. Further randomized controlled studies are needed to compare this procedure to regular cesarean section and evaluate neonatal outcomes.

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Approximately 20% of all pregnancies result in caesarean section (CS), and the rate continues to rise despite efforts to decrease this trend [1].

Compared to vaginal delivery, women after CS experience a slower recovery, more pain, a higher likelihood of requiring intravenous opioids, and an increased risk for complications in the postpartum period. These complications might affect maternal-infant bonding and lactation in the days following surgery [2,3].

Woman-centered care is recognized as a marker of quality in maternity services, and a positive birth experience is a primary focus of this initiative [4]. The extraperitoneal approach, which is known as French AmbUlatory CS, French CS, or FAUCS, is intended to enhance the birth experience. This approach has been shown to be associated with less need for intravenous analgesics, shorter hospitalizations, and a faster recovery, including earlier breastfeeding [5,6].

The literature lacks a large database regarding FAUCS performance. Ami and co-authors [5] published a retrospective study of FAUCS outcomes from 3341 procedures performed by six surgeons in France from 1997 to 2007. The study showed that 16.3% of the patients were discharged within 24 hours post-surgery. The mean hospital stay was 3.1 days compared to 6 days using the conventional CS method in France. The mean operation time was only 23 minutes. Only 2.9% of the patients required morphine in the postoperative period, and 20.9% did not require any painkillers. The complication rate was low, including bladder injury (0.3%) and hematoma in the retropubic space (0.2%).

Dimassi and colleagues [7] reported that implementation of the FAUCS procedure in a university-affiliated hospital in Tunisia was safe and successful, yet when compared with regular CS, the operations were longer, with a median (range) of 50 (40–60) vs. 35 (30–40) minutes, $P < 0.001$.

FAUCS in Israel has been performed mainly as a private surgery. However, FAUCS was recently introduced in public hospitals. At the Galilee Medical Center, we introduced the FAUCS technique in our maternity department in September 2021. The procedure was performed electively for suitable patients who were interested and who met the criteria of our protocol.

Surgical experience following a new procedure is often described using a learning curve [8-10]. The aim of this study was

to evaluate the individual learning curve of a senior surgeon team that performed FAUCS, and to assess short-term outcomes and complications.

PATIENTS AND METHODS

We conducted a retrospective study of 50 consecutive women who underwent FAUCS between September 2021 and March 2022 at the Galilee Medical Center. After institutional review board approval, data were retrieved from patient medical records. These included demographic data (age, body mass index [BMI], and parity), operation results (total surgical duration and estimated blood loss), postoperative care, and recovery. Postoperative pain was assessed according to a 10-point visual analogue scale (VAS). The time of postoperative spontaneous urination (hours post-surgery) was collected from reports of the nursing staff in the computerized database. Patients were encouraged by our staff to mobilize 3–4 hours post-surgery and to urinate. Other outcomes included the need for escape dose opioids, postpartum anemia as defined by hemoglobin < 7 (gr/dl); and time to discharge. The VAS scores were attained by our trained nursing staff at H-0 (at the end of surgery); and at 6, 12, 18, and 24 hours postoperative (H-6, H-12, H-18, and H-24). Newborn outcome measures included APGAR score at 5 minutes < 7 and cord pH. Surgical and postoperative complications included urinary bladder injury, postpartum hemorrhage (defined as bleeding > 1000 ml or the need for blood transfusion), postpartum endometritis, and incision site-related complications such as infection and hematoma. Maternal satisfaction was assessed about 1 month after discharge by three questions:

- On a scale of 0–10, how satisfied were you with your FAUCS surgery?
- Would you recommend FAUCS to a friend or relative? Yes/No
- If you had a regular cesarean section in the past, do you prefer FAUCS or the regular procedure?

Patient selection for FAUCS was based on inclusion and exclusion criteria pre-determined by the department's protocol. Inclusion criteria included women undergoing an elective surgery, over age 18 years, and gestational week 36–42. Exclusion criteria included placenta previa with antepartum hemorrhage, intrauterine growth restriction (fetal weight) below 5% or known doppler flow disturbances, severe fetal anemia, fetuses with malformations, and scheduling for CS with general anesthesia.

THE SOCIAL ASPECT OF FAUCS

In FAUCS, several measures are implemented to increase the mother's comfort and positive experience. The midwife and the partner, or a person of the mother's choice, accompany her throughout the operation. With the guidance of the midwife, the parents can watch the birth of their child as active participants, and the baby is transferred directly onto the mother's chest for early skin-to-skin contact. The option that the baby may stay with her throughout the remaining duration of the surgery makes the surgery as natural as possible [11].

ANESTHESIA AND THE SURGICAL PROCEDURE

The FAUCS spinal anesthesia protocol included intrathecal 7–12 mg heavy bupivacaine and intrathecal 12 mcg fentanyl, as described in 2017 [5]. Two senior surgeons performed all the FAUCS procedures. Each surgery was preceded by vaginal preparation with povidone-iodine, and urinary bladder emptying by a disposable catheter [12].

The main differences in the FAUCS surgical technique compared with regular CS include paramedian vertical opening of the aponeurosis, left paravesical extraperitoneal approach of the uterus, closure of the uterus using purse string suture, and the use of glue to close the skin [5,6,13] [Figure 1]. At the end of the surgery, catheterization is again performed.

POSTOPERATIVE CARE

According to the pain protocol and postoperative care, immediately after birth of the newborn, intravenous (IV) paracetamol 1 gram and IV lornoxicam 8 mg are given. In maternity wards, a standardized analgesic scheme is used, comprised of intravenous 1 gram paracetamol every 6 hours and ibuprofen 400 mg every 6 hours. An escape dose opioid of either IV tramadol or morphine for breast feeding mothers is administered when VAS is more than 5.

Spontaneous urination was encouraged from 4 hours after surgery. Normal oral food intake was initiated as soon as the woman had an appetite. If no complications presented and the woman was pain-free, discharge was possible 48 hours post-surgery.

STATISTICAL ANALYSIS

Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 27 (SPSS, IBM Corp, Armonk, NY, USA). The chi-square test, or alternatively Fisher's exact test (when expectancy < 5), was used to compare categorial variables. The independent *t*-test or Wilcoxon rank-sum test according to the variable distributions was used to compare continuous variables. Spearman correlation was used to correlate maternal satisfaction VAS score and maternal mean pain VAS score in 24 hours. $P < 0.05$ was considered significant.

RESULTS

CHARACTERISTICS OF THE STUDY POPULATION AND OF THE SURGICAL PROCEDURES

Fifty women aged 34.2 ± 5.6 years, mean BMI 29.24 ± 4.65 kg/m^2, underwent FAUCS. Of those patients, 23 (46%) underwent the procedure because of a previous CS, 6 (12%) for breech presentation, 5 (10%) for placenta previa (without hemorrhage), 5 (10%) for a history of third degree obstetrical perineal tear, 4 (8%) due to mater-

nal request, 3 (6%) due to twin pregnancy, and 4 (8%) due to other indications (suspected macrosomia, history of myomectomy, vasa previa, and genital condylomas). Table 1 shows basic characteristics of the study population. The mean operative time and median postoperative inpatient stay were 53.26 ± 11.62 minutes and 2 days (1–5), respectively.

THE EFFECT OF SURGICAL EXPERIENCE

The average duration of surgery was 53.26 ± 11.62 minutes. Surgical duration decreased as the experience of the surgery team increased: from a mean 58.26 ± 12.25 minutes for the first 15 procedures to a mean 51.17 ± 9.73 minutes for the following procedures ($P = 0.03$). The estimated blood loss was 600 ± 125 ml for the first 15 procedures, and 630 ± 121 ml for the following procedures. This difference was not statistically significant ($P = 0.432$). The rate of urinary bladder injury was not statistically different for the first 15 surgeries and the following procedures (0% vs. 2.8%, $P = 1.00$). The neonatal outcomes are presented in Table 2. Overall, there were 6/53 vacuum-assisted fetal extraction and 3 cases of cord pH < 7.2, although there were no neonates with Apgar score < 7 at 5 minutes.

ANALYSIS ACCORDING TO PREVIOUS CESAREAN SECTION

Overall, 28 (56%) women had undergone at least one regular CS in the past, and 11 (22%) of those had undergone two CSs. The mean operation time was similar between women with and without previous CS (55.73 ± 13.35 and 51.18 ± 10.14, respectively) [Table 2]. Moreover, operation time did not differ between women with a BMI score above or below 30 kg/m^2 (52.04 ± 9.8 and 54.84 ± 13.25, respectively, $P = 0.34$). The mean operation time was longer for women with two previous CS than women with one previous CS, 62.73 ± 12.1 vs. 55.73 ± 13.35, $P = 0.014$. Estimated blood loss and surgical complications were similar between women with previous CS and women who were undergoing their first CS [Table 2].

SURGICAL OUTCOME AND PATIENT SATISFACTION

Postoperative results are shown in Table 3. The mean VAS score rose from H-0 to H-12, while remaining under 2, and then declined to 0.64 ± 1.25. The mean VAS score in 24 hours was 1.08 ± 0.84. Six percent of the women received opiates in the maternity ward.

The mean time to spontaneous urination after the operation was 6.23 ± 3.73 hours; 44% of the women were able to mobilize and urinate spontaneously by 4–6 hours. Three women required insertion of an indwelling catheter. One had a urinary bladder in-

Table 1. Characteristics of women who underwent French AmbUlatory Cesarean Section

Characteristic	Total sample (n=50)*
Age (years), mean ± SD	34.2 ± 5.6
BMI (kg/m^2), mean ± SD	29.24 ± 4.65
Parity, range (%)	**1.5 (0–4)**
Previous CS	28/50 (56%)
Previous CS1*	17/50 (34%)
Previous CS2*	11/50 (22%)
Twin pregnancy	3/50 (6%)
Pregnancy related disease, n (%)	
GDM	6/50 (12%)
PIH	2/50 (4%)
Pregnancy week at operation (week)	38.4 (36.4–42.1)
Pre-operative hemoglobin, mean ± SD	11.7 ± 1.08
Presentation/lie, n (%)**	
Vertex	43/53 (86%)
Breech	9/53 (18%)
Transverse lie	1/53 (2%)

*Others: suspected macrosomia, vasa previa, genital condylomas, history of myomectomy

BMI = body mass index, CS = cesarean section, GDM = gestational diabetes mellitus, PIH = pregnancy induced hypertension, SD = standard deviation

Table 2. French AmbUlatory Cesarean Section surgical results (September 2021–February 2022)

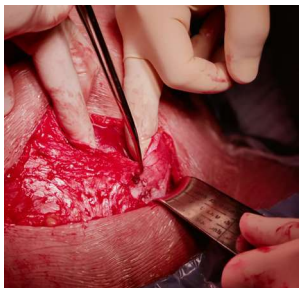
Characteristic	Result	*P*-value
Birth weight in grams, median (range)	3274 (1818–4094)	
Vacuum-assisted extraction	6/53 (11%)	
Cord pH, mean ± SD	7.29 ± 0.07	
Cord pH < 7.2	3/53 (6%)	
Apgar 5 < 7 (%)	0/53 (0%)	
Total sample	**53.26 ± 11.62**	
No PCS (n=22)	51.18 ± 10.14	$P = 0.17$*
PCS 1* (n=17)	55.73 ± 13.35	$P = 0.014$*
PCS 2* (n=11)	62.73 ± 12.1	
BMI < 30 kg/m^2 (n=25)	52.04 ± 9.8	$P = 0.34$*
BMI > 30 kg/m^2 (n=25)	54.84 ± 13.25	
Total sample	**600 (500–1000)**	$P = 0.40$**
PCS (n=25)	600 (500–1000)	
Non-PCS (n=25)	600 (500–800)	
Urinary bladder injury (%)		$P = 0.44$***
PCS (n=25)	0/28 (0%)	
Non-PCS (n=25)	1/22 (4%)	

*Independent samples *t*-test, **Wilcoxon Rank-Sum test, ***Fisher's exact test

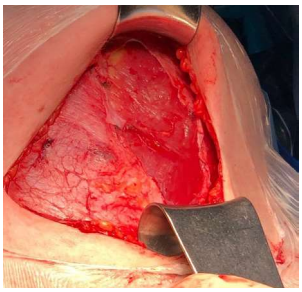
PCS = previous cesarean section, SD = standard deviation

Figure 1. French AmbUlatory Cesarean Section (FAUCS) and regular cesarean section

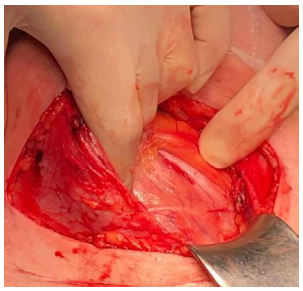
[A] Vertical incision of fascia



[B] After vertical opening of the fascia



[C] Left extraperitoneal approach



[D] Intact peritoneum after baby delivery and uterine closure

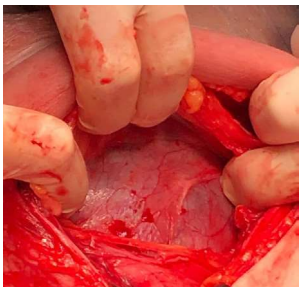


Table 3. French AmbUlatory Cesarean Section postoperative results (September 2021-February 2022).

Characteristic	Value
Pain (VAS score)*, mean ± SD	
H-0	1.14 ± 1.69
H-6	1.36 ± 1.78
H-12	1.52 ± 1.89
H-18	1.32 ± 2.07
H-24	0.64 ± 1.25
Mean VAS score in 24 hours	1.08 ± 0.84
Opiate administration on maternity ward (%)	3/50 (6%)
Time to spontaneous urination (hours), mean ± SD	**6.23 ± 3.73**
Spontaneous urination (0–4)	15/50 (30%)
Spontaneous urination (4–6)	22/50 (44%)
Spontaneous urination (6–8)	10/50 (20%)
Need for urinary tract catheter	4/50 (8%)
Postoperative hemoglobin (g/dl), mean ± SD	10.51 ± 1.24
Postoperative hemoglobin drop	1.19 ± 0.97
Postoperative anemia	
Hemoglobin < 7 gr/dl	1/50 (2%)
Need for blood transfusion	1/50 (2%)
Postoperative hospitalization in days, median (range)	2 (1–5)
Postoperative complications (%)	
Endometritis	1/50 (2%)
Incision hematoma	1/50 (2%)

*H-0 = immediately after surgery; H-6, H-12, H-18, H-24 = 6, 12, 18, and 24 hours postoperative, respectively

SD = standard deviation, VAS = visual analog scale

jury during the operation and required maintaining a urinary catheter for 5 days. The other two women had urinary retention and an indwelling catheter was inserted and left for 24 hours. After its withdrawal, voiding was successful. The mean VAS score for maternal satisfaction was 8.7 ± 2.19; 47 women (94%) responded that they would recommend FAUCS to a friend or relative. Of the 28 women who underwent a previous CS, 24 (85%) preferred FAUCS over a regular CS. The correlation coefficient (r) between maternal satisfaction as measured by VAS and mean maternal pain VAS at 24 hours postoperative was 0.33, $P = 0.02$.

DISCUSSION

The results of the current study show the feasibility of FAUCS during implementation in an obstetrics and gynecology department. Data of the first 50 procedures conducted by our surgical team showed significant improvement in the learning curve. Specifically, following the first 15 surgeries, the operative time decreased, while blood loss (ml) and the complication rate did not change.

Dimassi et al. [6] speculated that the multiple innovations associated with FAUCS could hinder its implementation. However, our experience showed that a senior ob-gyn surgeon with surgical experience and familiarity with anatomy can master the procedure within 15 performances. Interestingly, similar to our findings, the learning curve for the total operation time of regular caesarean sections was shown to flatten after performing 10–15 operations [14].

Our results of low pain scores postoperatively, and the need for opiates by only a small proportion of women, collaborate previous studies [3,6]. We found early mobilization and spontaneous voiding. Only a low proportion of urinary retention or the need for insertion of an indwelling catheter was noted. Our mean operation time of 53 minutes was similar to the 50-minute average reported for the first 60 FAUCS procedures performed in a university-affiliated hospital in Tunisia [7]. Moreover, our mean time to spontaneous urination of about 6 hours was similar to their results, as was our 3% rate of urinary bladder injury compared to their 2%.

Our rationale for introducing FAUCS was to offer women who must undergo CS early autonomy and a delivery experience that is as similar as possible to normal vaginal delivery. The early mobilization after FAUCS can improve a woman's experience by shorting the time to independent care of the baby, thereby improving mother–baby bonding. A factor that might enhance this early mobilization is that during the operation the linea alba is kept intact.

Hernández-Gascón et al. [15] demonstrated that the linea alba is the main structure responsible for abdominal wall activity and stability.

The extraperitoneal nature of the operation adds to the fast recovery, by keeping the peritoneum intact and preventing amniotic fluid and blood from contact with the bowel, thus reducing postoperative nausea, vomiting, and the risk of developing ileus [16]. Yapca and colleagues [16] showed that bowel function returned after extraperitoneal CS in 8 ± 4 hours compared to 13 ± 4 hours in women after regular CS [16]. Most women were discharged on day two postoperatively, similar to the usual discharge after vaginal delivery, and considerably faster than the usual discharge at day 4 following regular CS in our department. Early discharge is welcomed by most parents as it affords time with the extended family in a familiar environment. Indeed, a trend of early discharge after planned CS has been described [17,18]. In a randomized controlled study, Kruse et al. [19] concluded that parental postnatal sense of security was not compromised due to early discharge after 28 hours.

Following these results, an important question that arises is whether FAUCS is associated with an increased risk of complications. A randomized controlled trial that compared this procedure to CS according to Misgav Ladach technique showed no difference in intra- or postoperative complications [6]. Recently, a double-blind randomized controlled trial found that the FAUCS group had a longer surgical duration, a higher rate of intraoperative complications, and a higher rate of umbilical cord pH level of < 7.2 compared with the standard CS delivery group [20].

Our results supported those findings, although our postoperative complication rates were low, 3 (6%) neonates had cord pH < 7.2 with Apgar score > 7 at 5 minutes. Bladder injury was observed in one patient, and another had endometritis. These complications are not associated with the nature of the FAUCS surgery and might have occurred with other abdominal procedures, especially in women who had adhesions due to previous operations.

An important finding of our study is the high satisfaction rate of the women who underwent it. Most preferred it over the regular CS they had experienced in the past. Moreover, most stated they would recommend FAUCS to a friend or family member.

Our study had several strengths. As the FAUCS technique was available to suitable women, our sample was heterogeneous and reflected the women who usually performed elective CS. Second, the same two surgeons performed all the surgeries using a uniform technique. The limitations of the study include the retrospective design, the small number of patients, and the performance of the operation by two senior surgeons, thus precluding applying the conclusions to junior surgeons.

CONCLUSIONS

FAUCS is a feasible procedure with a high satisfaction rate and low pain. Further randomized controlled studies are needed to compare this procedure with regular CS and to assess the rates of adverse neonatal outcomes.

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