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Optimization of Surgical Sieve used for Caesarean Section

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Abstract

Caesarean section (C-section) has become a save and whenever indicated standard way of delivery. Moreover, C-section is one of the most frequent surgeries on women worldwide. It is mandatory to have an appropriate surgical sieve to perform a C-section and eventually to manage complications. The aim of the study was to optimize the surgical sieve used for C-section. Therefore, Centers of Excellence for obstetrics in Germany and USA were asked to provide information on their surgical sieves. We evaluated surgical sieves used for C-sections from eight centers. Surgical sieves of all centers had a standard set of instruments containing: clamps, needle holders, scissors, tongs, forceps, retractors and devices for bipolar electrocoagulation. Rarely used instruments were: uterine curettage, uterine dilatator, intestinal spatula, vaginal specula, drainage needles, birth spoon, sterilizable surgical suction, sterilizable scalpel handles. We analyzed the mean of instrument groups and discussed the results with surgeons and surgical nurses in our clinic. We adjusted our surgical sieve by significant reduction of clamps, reduction of needle holders, scissors, tongs, forceps bowls, sharp hooks and removal of monopolar devices.

Keywords: C-section; Surgical sieve; Surgical instruments; Technique of C-section.

Introduction

The history of the Caesarean section (C-section) began in ancient Rome, and possibly even earlier [1]. It has been continuously improved through the implementation of milestones of development in medicine. In ancient times and the Middle Ages, the Caesarean section was performed on dead or dying mother as an attempt to save the child's life (Rucker et al., 1951). From the seventeenth century Caesarean sections have been performed on live women. With uterotomy left open the mortality rate was as high as 52-100% until the second part of the 19th century [2]. The surgical delivery has been suggested as ultima ratio. Crucial development steps made C-section a standard and safe way of delivery.

Significant progress in the surgical technique was achieved by Max Sänger, who introduced the interrupted double layer sutures to close the median uterotomy. Sänger also paid much attention to antisepsis. As a result, the perioperative mortality rate dropped to 1-10% [1]. Another crucial step forward was the implementation of the horizontal incision of the lower uterine segment. The incision of the lower uterine segment reduced

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manipulations of the peritoneal cavity, and a reduction of injury of the contracting tissues of the uterus. The incision of the lower uterine segment has become fundamental to all modern surgical techniques of the C-section. The surgical techniques have further been improving.

The C-section is one of the most frequent abdominal surgeries in women, with increasing incidence [3]. The rates of C-section have been rising, reaching 15% of all birth worldwide. The frequency varies significantly between countries [4]. In Germany the rate of C-sections doubled from 15% in 1991, to 30% in 2019 [5]. In other European countries the increase of C-sections was comparable. C-sections are performed much less frequently in low-income countries, especially in some countries in Africa, where the frequency of this surgery falls below 5% [6].

The C-section has become a safe procedure that can reduce the maternal and perinatal mortality and morbidity when medically indicated [7]. There is an ongoing debate about the rising frequency and the justified medical indications for the C-section. In 1985 a group of international experts stated that, "there is no justification for any region to have a C-section rate higher than 10–15%"[8]. Recent systematic reviews showed that C-section rates higher that 9-16% do not reduce the maternal and neonatal mortality [7,9]. In 2015 the WHO statement on C-section rates was published [7]. The determination of the "ideal Caesarean rate" was left. According to the recent WHO statement, "CS should be undertaken when medically necessary, and rather than striving to achieve a specific rate, efforts should focus on providing Caesarean sections to all women in need…". The Robson classification has been developed to make the indications for C-section comparable based on objective criteria [10]. Some national and international guidelines recommend evaluating all women that are admitted for birth according to Robson criteria [5].

The most frequent indications for C-section in Germany are: state after C-section, pathological CTG, breech presentation, prolonged birth/birth arrest in the opening period. The current AWMF S3-guideline has adopted the urgency classification for C-section that was recommended by the National Institute for Health and Clinical Excellence (NICE). The indications for the C-section are divided into 4 urgency categories:

- Category 1: Immediate threat to the life of the woman or fetus.
- Category 2: Maternal or fetal compromise which is not immediately life-threatening.
- Category 3: No maternal or fetal compromise but needs early birth.
- Category 4: Birth timed to suit woman or healthcare provider.

Time is often of a priceless value in C-section.

The current AWMF S3-guideline for C-sections regards a time interval of less than 20 minutes between decision making and the fetal development as a quality marker of the clinical site for category 1 indications (emergency). In order to meet this high-level requirements best possible conditions must be created. The surgical equipment: instruments, devices, etc. must ensure a fast and safe handling, the clinical staff must be sufficiently trained an interdisciplinary medical support must be available at any time.

Recent data show that 232710 C-sections were performed in 679 hospitals in Germany in 2020. Of these, 10161 were performed for Category 1 indications. When an emergency C-section was performed, the time between the decision making and the fetal development was shorter than 20 minutes in 10130 (99.69) cases. The C-section is an established and well-organized standard procedure in all clinics for Obstetrics at any time in Germany.

The C-section is an essential surgical procedure. Improvement of surgical technique, equipment, and technical devices have changed the availability and the performance of the C-section. There are various models and modifications of instrument types available. Instruments and the sterilization are comprehensive available and affordable at least in industrial countries. As economical aspects are getting more and more important in medicine worldwide, the cost effectiveness also needs to be considered for this surgical procedure. The aim of the study was to compare the surgical sieves of high-volume clinics in both Europe and the US, and to make a recommendation about the surgical instruments that are actually required to perform a safe and efficient C-section.

Materials and methods

We evaluated the recent C-section statistics or our department in 2021.

The standard surgical technique of C-section at University Clinic Halle is the modified Misgav-Ladach technique.

Opening of the abdominal wall by skin cross-section and sharp incision of the fascia. Digital blunt expansion including the rectus abdomen. Sharp incision of the peritoneum with blunt extension. Insertion of the Fritsch hooks. Dissection of the plica vesicouterina caudally. Sharp incision with scalpel in lower uterine segment. Digital blunt extension of uterotomy to bds lateral. Manual release of the placenta. Closure of the uterus with a continuous suture. Inspection of the abdomen. Closure of the peritoneum. Closure of the abdomen by a continuous fascial suture. Subcutaneous adaptation by a few interrupted sutures. Skin closure with an intracutaneous suture.

From June until July 2022 clinics from Germany and the US were asked to provide information on surgical sieves used for C-sections. Of the 19 clinics contacted by email and/or phone call, eight clinics provided their surgical sieve list. All but one were high volume University clinics.

We counted the number of every model of the instrument types on the sieves. The mean of each instrument type was calculated. We compared the mean of each instrument type with the number of the corresponding instrument type on the surgical sieve of our clinic. We discussed the results of the comparison between the surgical sieves with the surgeons and surgical nurses of our clinic. The main topics of the discussions were:

- Modified Misgav-Ladach technique that used as standard surgical technique in our clinic for any category C-section.
- Frequency of C-sections in our clinic including the urgency

indications.

- Instruments that are used for each step of the C-section. Preferences of each surgeon were considered.
- Situation when additional instruments may be needed.
- How often additional instruments are needed approximately.
- Purpose to have standard instruments on the sieve and to store additional instruments separately in case of unpredictable unusual situation or complication.

Also, we looked at the instruments on the sieves of other clinics are and discussed if it can be useful to introduce some of them in our clinic.

Further, we introduced the surgical instruments and the sieve lists for C-sections to the medical students of the medical faculty of Halle-Wittenberg University. Finally, we adjusted our sieve list for C-sections, considering the means of instrument types as well as considerations of our surgeons and surgical nurses.

The company Aesculap AG – Part of the B. Braun Group allocated photos of surgical instruments that were used on the surgical sieves of participating centers for this publication.

Results

In 2021 444 C-sections were performed in the University Clinic Halle, 32 of these for category 1 indications. In all cases, the modified Misgav-Ladach technique was used. The time intervals between decision making and development of the fetus for emergency indications was:

- In 59,4% (n=19) between 5 and 10 minutes
- In 37,5 % (n=12) between 11 and 15 minutes
- In 3,1 % (n=1) between 16 and 20 minutes.

The time limit of 20 minutes did never expire.

474 C-sections were performed at the University clinic Halle in 2022. Of these, 40 were for Category 1 indications.

The response rate of clinics that were asked to provide the information on the surgical sieve used for C-section was 42,1% (8 from 19 clinics).

Thirteen models of clamps were used. The mean of clamps was 19.75 in a sieve (range 9-34).

Five models of needle holders were named with a mean of 2.5 in a sieve (range 1-4).

Eleven models of scissors were described. The mean of scissors in a sieve was 4.5 (range 3-7).

Nine models of tongs were used. The mean of tongs in a sieve was 7.375 (range 2-13)

Ten models of forceps were found on the sieve with a mean of 7.125 (range 5-9).

Retractors counted seven different models. The mean on the sieve was 4.5 (range 3-6).

Five bowls models of different form and amount were found on the sieves with an meant of 3 in a sieve (0-5).

Two models of uterine curette were found on the sieve with a mean of 0.875 (range 0-2).

The mean of the uterine dilatator on he surgical sieve was 0.75 (range 0-4).

Two models of intestinal spatulas wre counted. The mean was 0.375 (range 0-2).

Electrosurgery

• Bipolar

In each but one sieve there was a bipolar cable, mean 0.875 (range 0-1)

• Monopolar

A monopolar handle was on just three sieves, mean 0.375 (range 0-1).

One sieve contained a needle electrode, mean 0.125.

Three sieves contained a ball electrode, mean 0.375 (0-1).

A knife electrode was found on two sieves, mean 0.5 (range 0-1).

The mean of the scalpel handle was 0.625 (0-3). Other instruments

Lamp handles were found on 4 of 8 surgical sieves, 3 centers used 2 handles each and one center used 1 handle. The mean was 0.875.

Two sizes of vaginal specula were used, the mean was 0.25 (range 0-2).

The mean of Redon drainage needle spike was 0.5 (range 0-3).

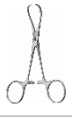
A birth spoon (Sellheim) was an integral part of the Caesarean section of one center, mean 0.125.

Also, a pool suction was named on the sieve of one center, with a mean of 0.125.

In accordance with the means of instrument groups from the surgical sieves, we adjusted the surgical sieve for C-section in our department (Table 1, column “University clinic Halle new”.). Most notable was the reduction of clamps from 34 to 19. Further, we removed monopolar devices from our sieve. We reduced the quantity of needle holders, scissors, tongs, forceps, and bowls by one each. After removal of sharp hooks, the number of retractors was reduced from 6 to 4 pieces. We did not extend our surgical sieve by other instrument types or modifications of instrument types already used in our clinic.

Additionally, a preparation set for disinfection of the operative field is used in our department. It consists of: 2 kidney bowls and 2 Maier grain tongs.

Table 1: Content of the surgical sieves for C-section in Obstetric centers. Mean of each instrument type and each model is provided. "University Clinic Halle new" shows the adjustment of the surgical sieve in our department.

Surgical Sieve	University Clinic Halle (old)	University Clinic Marburg	University Clinic Hamburg	München Clinic	University Clinic Mannheim	University Clinic Düsseldorf	University Clinic Regensburg	ohn Hopkins Clinic	MEAN	University Clinic Halle new	
Content	Quantity										
Clamps											
KOCHER-OCHSNER Clamp	8	4	6	6	2	4	14	2	5.75	6	
ROCHESTER-PEAN Clamp	12	6	4	6	2	8	4		5.25	5	
HALSTED mosquito clamp	2								0.25	0	
HEISS Clamp							2		0.25		
OVERHOLT Clamp	2		2	2		4	2		1.5	2	
Dissection clamp, S-shaped		2							0.25		
MIKULICZ clamp	4	4		2	4	4	4		2.75	4	
HEANEY hysterectomy clamp	4								0.5	0	
Towel clip for paper towels	2		1						0.375	1	
MIXTER clamp					2				0.25		
CRILE clamp				6	8			4	2.25		
Towel clip								2	0.25		

Tonsil clamp								1	0.125		
Needle holder											
DE BAKEY needle holder	2		1	1					0.5	1	
HEGAR-MAYO needle holder	2		2	2	1	2		2	1.375	2	
BABY-CRILE-WOOD needle holder					1	1	1		0.375		
MASSON needle holder						1			0.125		
HALSEY needle holder								1	0.125		
Scissors											
Hysterectomy scissors	1								0.125	0	
SIEBOLD scissors, S-shaped	1								0.125	1	
METZENBAUM-FINO scissors	2		2		2			1	0.785	2	
Thread scissors			1			1			0.25		
COOPER scissors		1	1						0.25		
Surgical scissors				1	1	1	1		0.5		
LEXER dissection scissors		1		2	2		1		0.75		
Umbilical cord scissors			1						0.125		
SIMS uterine scissors		1	1			1			0.375		
MAYO dissection scissors	1						2	3	0.75	1	
LISTER bandage scissors			1		1			1	0.375		

Tongs											
ALLIS tongs (clamp)	2							2	0.5	2	
BABCOCK tongs (clamp)								2	0.25		
FOERSTER sponge stick	1		1	6	2			9	2.375	1	
SIMPSON delivery forceps				1		1			0.25		
LAHEY bile duct tongs (forceps)					1				0.125		
ULRICH AESCULAP washing tongs						4			0.5		
Ovarian grasping tongs (forceps)						2			0.25		
NOTO polypenal tongs		4							0.5		
MAIER grain tongs	4	1	1	2	4	2	5		2.375	3	
Forceps											
WAUG surgical forceps	1		1			2			0.5	1	
Anatomic forceps	2			2	1	1		1	0.875	2	
Surgical forceps	2	2		1	2	1		1	1.125	2	
Blunt forceps	1	1							0.25		
Russian forceps		2						1	0.375		
DE BAKEY atraumatic forceps		2	1		1		2		0.75		
BONNEY forceps								1	0.125		
ADSON forceps	1	2	1	2			1	2	1.125	1	
Atraumatic forceps, isolated			1	1	1	3			0.75		
Surgical forceps			3		1		2	1	0.875		
Retractors											
ROUX retractor	2	2	1	2	2	2	2		1.625	2	

FRITSCH retractor	2	2	2	4	2	2	2		2	2	
Sharp hooks	2								0.25	0	
COLLIN retractor		1							0.125		
RICHARDSON retractor								3	0.375		
GOELET retractor								1	0.125		
DOYEN abdominal retractor								1	0.125		
Bowl											
Stainless steel bowl	2					2			0.5	1	
Kidney bowl	2	2	1	2		1	3		1.375	2	
Kidney bowl extra large		1							0.125		
Measuring cup			1						0.125		
Laboratory bowl 0,063/0,16/0,4				3			1		0.5		
Uterine curette											
Uterine curette blunt FIG.15	1		1	1	1	1	1		0.75	1	
BUMM uterne curette blunt						1			0.125		
Uterine dilatator											
HEGAR uterine dilatator	1				1	4			0.75	1	
Intestinal Spatula/ intestinal retractor											
HABERER retractor	1								0.125	1	
RIBBON retractor								2	0.5		
Electrocoagulation											
Bipolar cable	1	1	1	1	1	1	1		0.875	1	

Slim-Line handle	1		1			1			0.375	0	
Needle electrode	1								0.125	0	
Ball electrode	1				1	1			0.375	0	
Knife electrode	1				1				0.25	0	
Knife handle											
Knife handle	2						2		0.5	0	
Others											
Lamp handle	1	2	2		2				0.875	1	
Specula 180/40 und 130/35						2			0.25		
Redon drain needle spike						3	1		0.5		
Birth spoon Sellheim							1		0.125		
Surgical suction								1	0.125		

Discussion

To find the optimal combination of instruments on the surgical sieve used for C-section we asked Centers of Excellence for obstetrics in Germany and USA to provide information on their surgical sieves calculated the means of each instrument type and discussed the results of the comparison between the surgical sieves with the surgeons and surgical nurses of our clinic. Finally, we adjusted the surgical sieve used for C-section in our clinic (s. Table 1 “University Halle new”).

Surgical sieves of all centers had a standard set of instruments containing clamps, needle holders, scissors, tongs, forceps, retractors, and devices for bipolar electrocoagulation. Many types and modifications of these standard instruments were used. This is likely due to the individual preferences of the surgeon performing the procedure. We did not calculate the different models and modifications of instrument types separately, as they have the same function during the surgical procedure. There was a significant difference in quantity of the standard instruments between the centers.

Rarely used instruments were the vaginal specula, drainage needles, birth spoon, sterilizable surgical suction, and sterilizable scalpel handles.

The C-section has become a standard procedure. Because of the normalization of this procedure, the scope of the surgical sieve may become a routine that is not questioned. We assume that the consideration of C-section as a routine procedure may explain the low response rate of 42,1% to provide the information on the surgical sieve. However, it may be worthwhile to take a critical look on the contents of the surgical sieve for C-section and to adjust them to have all instruments on the instrumental table ready to use that are really needed when C-section is performed. At the same time, an overload of the surgical sieve with too many instruments that are not used and may even interfere with the procedure of surgery should be avoided. The optimization of the surgical process in the last few decades may have led to a possibility to reduce surgical instruments used for C-section.

Surgical technique

Different surgical techniques have been developed for the C-section. The Misgav-Ladach, the modified Misgav-Ladach and the Pfannenstiel-Kerr technique have been found to be the most frequently used techniques [11]. The Misgav-Ladach -Ladach technique have been suggested as a modification of the Joel-Cohen technique that has been described by Stark [12].

In Pfannenstiel technique the Pfannenstiel incision is used. The fascia is opened by a transverse sharp dissection. The peritoneum is sharply dissected in the longitudinal way. The hysterotomy is performed transversally and closed with two layers of continuous sutures. The peritoneum is closed with continuous sutures. The fascia and the skin are closed using continuous or interrupted sutures.

In the Joel-Cohen technique a straight transverse incision is used that is placed 3 fingers below the line of the spinae iliaca superior. The fascia is opened sharply in the midline and extended by the blunt finger dissection. The peritoneum is opened by the blunt finger dissection. The hysterotomy is performed by a sharp incision in the midline and extended by blunt finger dissection. The hysterotomy is closed by interrupted sutures.

In Misgav-Ladach technique the Joel-Cohen entry is used. The hysterotomy is closed by a single layer locked continuous suture The peritoneum is not closed by sutures. The fascia is closed by continuous suture. The skin is closed by two to three mattress sutures; Allis forceps are used to approximate skin edges between the sutures for a few minutes.

In modified Misgav-Ladach technique subcutaneous sutures and various skin closure sutures are used. The hysterotomy is closed by a single-layer non-locking continuous suture.

The surgical techniques were compared in a Cochrane Review [13]. The Joel-Cohen based techniques have been determined to be superior to the Pfannenstiel Caesarean section in the following ways: less blood loss, shorter operating time, postoperatively less time to oral intake, shorter duration of postoperative pain, fewer analgetic injections, and shorter time from skin incision to birth of the child.

In accordance with the current AWMF S3 guideline, the blunt dissection of the abdominal wall should be performed after a transverse skin incision. The uterotomy should be extended by blunt finger dissection.

Advantages have been shown for blunt dissections whenever possible. The closure of the peritoneum and subcutaneous tissue is optional. These may contribute to a limited number of instruments that are needed for C-section.

Needles and sutures

Decades ago, needles required threading and produced large holes as a passage of double layer of suture through the wound was necessary. Catgut and chromic catgut were predominant suture materials until the 1980s before they were superseded by synthetic sutures with advantageous characteristics [14-15]. The closure of the wound was a time consuming and instrument intensive process. The development of atraumatic surgical needles and synthetic sutures made a continuous closure of the uterotomy wound possible. This reduced peri- and postsurgical complication and saved operating time [16,17]. Modern surgical needles and sutures may also reduce the quantity of clamps that are needed to perform the C-section as the ends of the interrupted sutures don't have to be held together usually by a clamp before knotting. Moreover, it may be less frequently needed to clamp an open vessel to stop bleeding.

Surgical task lighting

The lighting used to perform operations in the surgical field has been dramatically improved in recent history. In the 19th century, natural daylight or candlelight were the only sources of light available to perform a surgery. In today's surgical rooms, high technology scialytic lamps are available for the best possible illumination in surgical procedures. The surgical lamps must meet particular requirements concerning central illuminance, light field center, depth of illumination, shadow dilution, etc. [1]. The development is continuing in the field of illumination, and surgical lamps are only improving. The modern illumination makes the visibility of surgical procedures precise and clear at levels that could probably not even be imagined decades ago.

Electrocoagulation

The introduction of electrocoagulation enables the surgeon to stop at least small and moderate bleeding quickly and efficiently without additional instruments. The use of clamps and subsequently ligation is mostly limited to big vessels.

Surgical suction

The surgical suction further improved the visibility of modern-day surgical procedures by removing fluid from the operating field [16-17]. Less clamps, tongs and forceps are needed to establish a sufficient view in the surgical procedure.

Limitation

We lack the information of whether some centers use surgical instruments in addition to the provided surgical sieve lists. Those may be single-use instruments or instruments that are packed outside the main surgical sieve and are used routinely or in case if needed. Obviously, the majority of the clinics prefer single-use scalpels, as only two clinics had scalpel handles in the sieve. The same refers to the surgical suction, lamp handles, and probably bowls. One center did not have electrocoagulation devices on the sieve list, although it is very unlikely that this center does not use electrocoagulation, and we postulate that the electrocoagulation devices are packed outside of the surgical sieve. Further, we have no information on the surgical technique and probable modifications of surgical steps in participating clinics. We did not investigate the number and types of instruments that are used step by step in the surgical procedure. In this context, clinics that use instruments rarely found on the C-section sieve are of a particular interest. Interestingly, according to some publication the C-section technique may depend on the urgency of the surgical indication. Regional differences also must be considered. For instance, in UK for planned indications the Pfannenstiel technique may be used more frequently, whereas the Joel-Cohen based techniques may be preferred for emergency indications. In contrast to that, the Pfannenstiel technique may be more often the technique of choice for emergency and urgent indications in the US [13].

Conclusions

We conclude that a reduction of instruments on the surgical sieve for C-section is possible without compromising the safety or efficacy of the surgery. Surgical instruments that are used for C-section should be adjusted considering the optimization of the surgical technique, the improvement of equipment and devices in the operating rooms. The removal of redundant instruments from the surgical sieve may improve the overview within the surgery and make the procedure more dynamic. This is especially important in C-section for emergency indication when every moment can save life. Moreover, the reduction of instruments on the sieve may reduce sterilization costs. In special situations, additional instruments can be used that are stored outside the sieve. We postulate that an inter-clinic standardization of the surgical sieve used for C-section may be helpful to further improve the process of C-section and to optimize the economic aspects of this high frequent surgical procedure.

To our knowledge, it is the first study that compares the content of C-section sieves of different clinics. Further investigation may focus on comparison of instruments that are used for particular surgical steps and the sets of instruments when different techniques of C-section are performed.

Declarations

Author contributions: Conceptualization, M.T. and I.H.; methodology, M.T.; software, I.H.; validation, M.T., I.H.; formal analysis, I.H.; investigation, I.H.; resources, M.T. and I.H..; data curation, I.H.; writing—original draft preparation, I.H.; writing—review and editing, M.T.; visualization, I.H.; supervision, M.T.; project administration, M.T.; funding acquisition, "not applicable" All authors have read and agreed to the published version of the manuscript."

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