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RESEARCH ARTICLE

Risk factors and management of surgical site infection in caesarean section patients at a teaching hospital

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ABSTRACT

Objectives: This study was conducted to recognize the risk factors particularly the modifiable ones that may be related to the woman, pregnancy or to the technique itself and implementing the strategies to prevent, diagnose and treat infection so that the morbidity and mortality related to the post-surgery sepsis can be reduced. **Methods:** Present study was a prospective observational study conducted at department of Obstetrics & Gynaecology, Government Medical College, Aurangabad for the duration of 2 years (October 2018 to September 2020). SSI diagnosed by clinical features, CDC criteria, depth of infection and contamination, treatment modalities and morbidity related to SSI are analysed. **Results:** Risk factors noted for SSI in caesarean section patients were emergency caesarean section, 3 or more per vaginal examination, duration of surgery > 38 mins, anaemia, PROM, previous surgery (caesarean section/ hysterectomy/ myomectomy/ laparotomy), hypertensive disorders of pregnancy, BMI > 30 kg/m^2, blood loss >500ml, age > 30 years & GDM. **Conclusion:** Always screen for high risk factors preoperatively and anticipate SSI. Incidence in our study was 4.7, also means that 95.3% of those who underwent caesarean section did not develop SSI. So, antibiotic policy can be updated as that a second line antibiotic should be started by anticipating SSI in those who have any high-risk factors.

Keywords: SSI, wound gape, LSCS SSI, wound discharge, wound sepsis.

Millions of surgical procedures are conducted around the world each year. The majority of procedures result in surgical wounds that will heal by primary intention. This is where wound edges are reapproximated using sutures, staples, clips or glue, either alone, or in combination [1]. The rate of SSI ranges from 3% to 15% worldwide [2]. With the global increase in caesarean section rate, it is expected that the occurrence of SSI will increase in parallel, hence its clinical significance [3]. A surgical site infection (SSI) is an unintended and often times preventable consequence of surgery [4]. The single most important risk factor for postpartum maternal infection is delivery by caesarean section [5]. Maternal morbidity related to infections has been shown to be eight fold higher after caesarean section than after vaginal delivery [6].

CDC defines surgical site infection as an infection which occurs at the site of incision or operative site (including drains) within 30 days of surgical operation if no implant is left in place / within 1 year if an implant is left in place [7], the infection must appear to be related to the surgical procedure [8]. The development of an SSI depends on contamination of the wound site at the end of a surgical procedure and specifically relates to the pathogenicity and inoculum of microorganisms' present, balanced against the host's immune response [9]. The 2 microorganisms that cause SSIs are usually derived from the patient (endogenous infection), being present on their skin [10]. Exogenous infection occurs when microorganisms from instruments or the theatre environment contaminate the site at operation[11]. Staphylococcus aureus is the most common organism isolated in SSI. Gram-negative bacilli, coagulase negative staphylococci, enterococci and E. coli are other organisms

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commonly isolated from SSI [12].

Risk factors for developing post caesarean section SSI are divided into 3 categories host related, pregnancy and intrapartum related factors, procedure related factors [13].

• Host related - younger or older age, malnutrition, anaemia, obesity, pregestational diabetes mellitus, previous caesarean delivery, maternal preoperative condition, ASA grade > 3.

• Pregnancy related - GDM, PROM, HDP, greater number of vaginal examinations, prolonged labour prior to surgery, internal foetal monitoring and chorioamnionitis.

• Procedure related - emergency, non-use of prophylactic antibiotics, caesarean hysterectomy, need for blood transfusion and in surgeries of longer duration. Surgery duration of more than 1 is also found to be a risk factor.

Recognizing the risk factors, particularly those that are modifiable, proper perioperative preparation and use of distinct surgical techniques have been reported to affect the rate of SSI. SSI after caesarean section delay recovery, prolong hospitalization or outpatient treatment, necessitate readmission, increase hospital bills. Given its substantial implications, recognizing the consequences and building strategies, creating bundles of evidence-based elements to prevent and treat SSI are essential for reducing the post caesarean maternal morbidity and mortality. This study was conducted to recognize the risk factors particularly the modifiable ones that may be related to the woman, pregnancy or to the technique itself and implementing the strategies to prevent, diagnose and treat infection so that the morbidity and mortality related to the post-surgery sepsis can be reduced.

Materials and methods

Present study was a prospective observational study conducted at department of Obstetrics & Gynaecology, Government Medical College, Aurangabad. Study was conducted for the duration of two years from October 2018 to October 2020 after approval from institutional ethics committee.

Inclusion criteria: All pregnant women who underwent emergency and planned LSCS at our tertiary care centre and had surgical site infection.

Exclusion criteria:

• LSCS done in other hospital and referred to our tertiary centre for complication.

• Those who had pre-existing skin infection in the surgical incision site.

• Patient who did not give consent to participate in the study.

Sample size for present study was 400 cases. After written valid informed consent of patient, case proforma filled with all details like basic demographic data which includes age, residence, socioeconomic status, address. History regarding previous obstetric history, risk factors, history of previous surgery, surgery related variables like indication of caesarean section, duration of surgery, duration of PROM before surgery, duration of labour before surgery, technique of skin incision and closure technique, average blood loss during surgery.

SSI diagnosed by

- Clinical features-erythema, induration, wound discharge, wound gape, burst abdomen
- CDC criteria - depth of infection.

The CDC describes three levels of surgical site infection[14] – 1) Superficial incisional - affecting the skin and subcutaneous tissue; 2) Deep incisional - which affects the fascial and muscle layers; 3) Organ and space infection - which involves any part in the body other than the incisional that is opened or manipulated during the surgical procedure.

- Degree of contamination -
  - Clean: Non-infective operative wounds in which no inflammation is encountered. These are elective, primarily closed, and drained with closed drainage system when required.
  - Clean contaminated: Operative wounds in which respiratory, alimentary, genital or urinary tract is entered under controlled conditions and without unusual contamination. Provided no evidence of infection or a major break in sterile technique is encountered.
  - Contaminated: Fresh, accidental wounds, operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered.
  - Dirty: Old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that organisms causing postoperative infection were present in the operative field before the operation.

Treatment modalities included – 1) Conservative management - medical and dressing, correction of

underlying risk factors; 2) Combines management - surgical and medical combine. The data was collected systematically and entered in Microsoft excel and analysed and expressed in terms of percentage, mean and standard deviation.

Results

Incidence of SSI was 4.7 at our tertiary care centre. Incidence of SSI was found to be more in emergency LSCS than in elective LSCS as depicted in table 1. Incidence of SSI in emergency LSCS was 4.9% and in elective LSCS it was 2.88%.

Table 1: Incidence of surgical site infection

Surgery	No. of cases	No. of cases of SSI	Incidence of SSI
Caesarean section	8503	400	4.7
Emergency LSCS	7604	374	4.9
Elective LSCS	899	26	2.8

Table 2: Distribution according to risk factors of SSI

Risk factors* (n>400)	Frequency	Percentage
Emergency caesarean	374	93.5
Number of pervaginal examination 3 or more	272	68
Duration of surgery > 38 mins**	269	67.25
Anaemia (haemoglobin <11g/dl)	222	55.5
PROM	216	54
Previous surgery	214	53.5
Hypertensive disorders of pregnancy	158	39.5
BMI > 30	93	23.25
Effective blood loss >500ml	75	18.75
Age > 30 yrs	74	18.5
GDM	18	4.5

* Multiple risk factors were present in many patients
**According to review by CDC, cut off of 38 minutes was taken

Table - 2 depicts the risk factors for developing SSI in our study. Most common risk factors were caesarean section done in emergency settings (93.5%), increased pervaginal examination (68%), increased duration of caesarean section (67.25%), anaemia (55.5%), premature rupture of membranes (PROM) (54%). In our study, 218 patients out of 400 had PROM. Amongst them, 66.1% had PROM for more than 12 hours, 33.9% had PROM for less than 12 hours. The mean duration since rupture of membranes was 14.43±4.28 hours. 53.5% had history of uterine surgeries out of which 30.75% had previous one scar and 20.75% had previous 2 scars. 39.5% patients had hypertensive disorder of pregnancy. Other risk factors found were hypertensive disorders of pregnancy (39.5%), obesity with BMI>30 (23.25%), blood loss during surgery more than 500ml (18.75%) and gestational diabetes mellitus was found in 4.5% of patients with SSI. Duration of labour before caesarean section is also an important risk factor. The majority of the patients were in labour (83.75%) before caesarean section and only few of them were not in labour (16.25%) before section. 36.25% were in spontaneous labour and 47.5% were induced. Our study shows 83.75% of the patients were in labour, for less than 6 hours in4.75%, more than 6 hours and less than 12 hours in 17%, more than 12 hours in 62% and 16.25% were not in labour. The mean duration of labour was 14.80±4.71 hours. Table - 3 shows different surgery related variables like indication of caesarean section, duration of surgery, surgical techniques like skin incision type (Pfannensteil/vertical), tissue handling, skin closure techniques (mattress/ subcuticular/ stapler), blood loss during surgery.

Table 3: Surgery related variables

Surgery related variables		Frequency	Percentage
Indication of caesarean section	Previous caesarean section	184	46
	Prolonged PROM	106	26.5
	Foetal distress	88	22
	Failure of induction	39	9.75
	Obstructed labour	28	7
	Malpresentation	26	6.5
	Others**	16	4
Duration of surgery >38 minutes		269	67.25
Skin incision type	Pfannenstiel	387	96.75
	Vertical	13	3.25
Skin closure techniques	Mattress suturing	326	81.5
	Subcuticular suturing	70	17.5
	Stapler	4	1
Blood loss > 500ml		75	18.75

Table 4: Distribution according to diagnosis and treatment modalities

Diagnosis and treatment		Frequency	Percentage
Time of diagnosis	During Post op stay at hospital	333	83.25
	Re admission	67	16.75
Type of wound infection	Wound discharge	294	73.5
	Partial wound gape	23	5.75
	Full length wound gape	75	18.75
	Burst abdomen	8	2
Classification of wound infection	Clean	112	28
	Clean contaminated	249	62.25
	Contaminated	36	9
	Dirty infected	3	0.75
Depth of infection	Superficial incisional	294	73.5
	Deep incisional	98	24.5
	Organ & space infection	8	2
Organism isolated by wound swab culture (More than one organism isolated in many)	S. aureus	72	18
	MRSA	135	33.75
	E. coli	44	11
	Klebsiella	36	9
	Psuedomonas aeruginosa	35	8.75
	Enterococcus	9	2.25
	Others (proteus, acenobacter)	17	4.25
	Sterile	112	28
Mode of treatment	Medical	294	73.5
	Secondary healing	9	2.25
	Combined management (medical+ surgical)	97	24.25
Mean duration of stay in hospital		13.62±4.84 days	

Diagnosis and different treatment modalities were studied (table 4). Majority (83.25%) of the patients were diagnosed during the hospital stay itself and 16.75% needed re admission. Wound discharge (73.5%) was the most common type of wound infection (out of which - 49.7% had serous, 9.2% hematoma, 32.3% has serosanguinous, 8.8% had purulent wound discharge), followed by partial length wound gape (5.75%), full length wound gape (18.75%), burst abdomen (2%). Majority of the wound infection were clean contaminated (62.25%) and superficial incisional type of infection (73.5%). Among the organisms isolated by wound swab culture, methicillin resistant S. aureus was most common (33.75%). Other organisms isolated were S. areus, E. coli, Klebsiella, Pseudomonas aeruginosa, enterococcus, proteus, acenobacter and 28% had sterile report with no organisms isolated.

S. aureus was found mostly sensitive to linezolid, doxycycline, clindamycin, gentamycin. Staphylococcus with MRSA to linezolid, clindamycin, doxycycline and piperacillin/ tazobactam, meropenem, amikacin to e. coli group and Klebsiella was most sensitive to gentamycin, meropenem, piperacillin/tazobactam and Pseudomonas to imepenem, meropenem, pipercillin/tazobactam and linezolid, ampicillin for enterococcus.

73.5% of the patients were managed by medical management. 9 patients with wound gape were managed with conservative management and wound was healed by secondary intention. 22.25% of the patients had to undergo secondary suturing and when needed rectus sheath repair done and 2% with exploratory laparotomy for burst abdomen and organ space infection. 3 patients needed debridement under anaesthesia before resuturing of wound. In our study 12 patients had SSI again in secondary sutured wounds, where 2 of them needed suturing again, 2 of them healed by secondary intention, rest managed by medical management. Average duration of stay of post caesarean section patients without SSI was 5 days in our hospital. The mean duration of stay in patients with SSI in hospital was 13.62±4.84 days. Regarding morbidity related to SSI was deep wound infection (26.5%), need of re surgery (24.25%), need of re admission (16.75%), hospital stay for more than 20 days (6.5%). There was no mortality related to SSI in our study.

Discussion

This study was conducted to recognize the risk factors particularly the modifiable ones that may be related to the woman, pregnancy or to the technique itself and implementing the strategies to prevent, diagnose and treat infection so that the morbidity and mortality related to the post-surgery sepsis can be reduced.

Prolonged labour and rupture of membranes contribute to amniotic fluid colonization from the normal flora of the lower genital tract and lead to surgical wound and peritoneal cavity contamination. The present study showed that 68% had repeated pervaginal examinations which was consistent with Margaret A. Olsen et al [15] study (85.2 %), Rose et al study[16] (89.5%) who had repeated vaginal examinations. Optimum vaginal examination should be as minimal as possible and even when it is done, it should be done with all aseptic precautions. Significant association was found between SSI and PROM in many studies. In Devjani De et al [17] study, it was interpreted that PROM > 24hrs is likely to increase the chances of infection by 182% and similar findings were seen in other two studies [16,18,19]. This is due to ascend of infection following breach in membranes which are considered as protective against infection. Prolonged labour is associated with increased risk of SSI. Labour pain causing maternal fatigue and dehydration, ischemia exerted by the presenting part make favourable condition for microbes and hence infection. In a study[18] the mean duration of labour in those who had SSI was 6.0 ± 8.5 hours where as it was only 2.8 ± 4.7 hours who had no SSI. Similarly J Kalibushi Bizimana et al [20] also showed that significant association was found between prolonged (>12h) labour and development of SSI which is consistent with the present study. The mean duration of labour prior to caesarean section was 14.80±4.71 hours. The incidence was more in induced labour as in induction of labour, usually we will wait at least for 12 to 18 hours before labelling it as failure of induction, induction is also a procedure which should be done under all aseptic precautions, care to be taken especially in cases of premature rupture of membranes, diabetes. In prolonged labour, if hydration is not maintained they have risk of intraoperative and postoperative blood loss which also interferes in healing of wound.

Obesity as also a well-known cause for SSI [17,19,20,21] and may be related to hypo-vascular thick subcutaneous tissue which results in lower immunity, larger and / or longer than usual skin incision with wider wound, and less availability of penetrated antibiotics into adipose tissues, limited mobility. Every effort should be made to reduce SSI by following few preoperative techniques and surgical techniques like use of drains in the subcutaneous plane, proper approximation of tissues, achieving haemostasis especially in the subcutaneous plane, improve the diet, early mobilization. Other

complications of obesity in patients who underwent caesarean section should be taken care off.

P De Nardo et al [21] stated, as per the surgical procedures, a midline vertical incision was the procedure of choice by far, especially among less experienced doctors. So, the incidence of SSI was seen more by default in patients with vertical skin incision. Whereas in other studies had SSI in patients who underwent caesarean section by transverse incision like in our present study. This may be because the most commonly used technique by default was transverse or Pfannensteil incision. Many studies showed that the risk of SSI was more in those who underwent procedure under emergency settings [17,18,20,22,23]. Shaymaa Kadhim Jasim et al[23] study showed that emergency procedure was linked to SSI through more frequent vaginal examinations with greater opportunity for membranes to rupture before delivery, less concerns about sterility, and absence of prophylactic antibiotics on time, uncorrected anaemia and nutritional deficiencies. With the increase in duration of surgery, the chance of developing of SSI is found to increase. Shapiro et al[24] reported that with each hour of surgery the infection rate almost doubles and in another study [17] 53.3% of patients with surgery duration >45 minutes developed SSI. Similarly, Lilani et al [25] reported a rate of 38.46% for surgeries that lasted more than 2 hours and Johnson et al [26] found an increased rate of SSI in those duration was >30 minutes. In the present study, 67.25% had SSI whose duration of surgery exceeded 38 minutes. This finding relates to the pharmacokinetics of the antibiotic prophylaxis and to the greater bacterial wound contamination that occurs in lengthy clean-contaminated surgeries. Regarding skin closure techniques, SSI was more common in subcuticular sutures followed by mattress fashion sutures [20], however in settings where mattress sutures are routinely used, SSI was found to be increased in mattress type of sutures by default [21,23] like in present study.

Superficial incisional type of wound infection is more common than deep and organ space infection in the which is a finding in many studies [15,16,20,21,22] similar to the present study. Deeper the wound more is the difficulty in management of SSI and increase the morbidity and risk of reoperation. Most common organism isolated in the wound swab was Staphylococcus aureus in many studies[17,20,21,27] which is also true in our study and found mostly sensitive to linezolid, doxycycline, clindamycin, gentamycin. However, in some studies [22, 28], E. coli was most common organism isolated as it is the most common flora found. Majority of SSI are managed by conservatively. In the study conducted by J Kalibushi Bizimana et al[20] most SSI were managed by wound opening, pus drainage, dressing twice daily and antibiotics, based on sensitivity found and only few needed surgical intervention like debridement. In a review [16] the treatment for SSI was done by observation only (9.5%), antibiotics only (47.6%), wound exploration (14.3%). In the present study, majority (73.5%) of the patients were managed by medical management. The management was done according to the standard operative protocol of our tertiary care. Medical management included high protein diet, antioxidants, healing agents, antibiotics according to the culture sensitivity report, sterile dressing of wound, release of sutures allowing the drainage of collection.

Conclusion

SSI after caesarean section delay recovery, prolong hospitalization or outpatient treatment, necessitate readmission, increase hospital bills, all of these leading to substantial physical and emotional burdens on the mother, increase in morbidity and mortality. Always screen for high risk factors preoperatively and anticipate SSI. Antibiotic policy can be updated as that a second line antibiotic should be started by anticipating SSI in those with high-risk factors. Identifying the nutritional deficiencies and treating them is very vital. Following aseptic precautions, good surgical skills and infection prevention protocols should be made sure. Development and implementation of protocols will help the obstetric staff in early detection of risk factors causing infection, targeting strategies towards high-risk women and auditing SSI will help in reducing maternal morbidity and mortality. Furthermore, prevention is better than cure.

Conflict of interest: None. **Disclaimer:** Nil.

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