ABSTRACT

Aims: to determine the incidence of post-operative infections after cesarean section and resistance profile of the isolated germs.

Method: this study was carried out from February to April 2014 at the service of obstetrics and gynecology and at the bacteriology laboratory of Benbadis University Hospital of Constantine. The analysis was carried out on 58 strains isolated from different pathological samples collected from women who have had cesarean section (C-Section). The identification of bacteria was achieved by the conventional methods used in the laboratory, namely the study of their morphological, biochemical API cropping and galleries (analytical index profile). The detection of resistance phenotypes was studied by the conventional method of dissemination of antibiotic medium disks agar Mueller Hinton and reading and interpretation criteria recommended by the Clinical and Laboratory Standard Institute (CLSI).

Results: during our study 36 cases of maternal infectious complications post caesarean were identified and 36 strains were isolated from various samples: parietal, vaginal and urinary. Isolated strains are in the following descending order: *Escherichia coli* and *Staphylococcus*, followed by *klebsiella pneumonia*, *Streptococcus*, *Acinetobacter spp*, *Enterococcus spp*, *Morganella morganii* and yeasts and finally *Citrobacter diversus*. The five ESBL producing strains belong to *Klebsiella pneumoniae* (4 isolates), *Escherichia coli* (1 isolate).
Conclusion: The present study demonstrated that the C-section should not be considered an easy option because it is not devoided of morbid maternal complications. The diagnosis of these post-cesarean infections has identified the main germs in question. Prevention is the best way to fight, and therefore improve maternal prognosis.

Keywords: Post-cesarean infections- Surgical wound infections- Antibiotics-Multidrug-resistant bacteria

Introduction

The post-cesarean infections are one of the most common complications of surgical interventions in obstetrics and gynecology department. These infections include urinary tract infection, endometritis, wound infection, perineum and sepsis infection [1]. The post-cesarean infections are a problem in hospital hygiene that increases the patient hospitalization days’ average from 2 to 7 days [2]. Due to the heavy management of these infections, they are potential sources of multi-resistant germs. Therefore, the present study aimed to report the epidemiology of postoperative isolates collected from gynecology and obstetrics department HUC of Constantine and their antibiotic resistance profile.

Material and methods

Maternity of Constantine University Hospital performs about 9,500 deliveries per year, nearly 3,500 women undergone caesarean labor. Patient postpartum period follow-up care was carried out by midwives. Any suspicion of infection is confirmed by the resident obstetrician. The diagnosis of infection of superficial or deep parietal surgical site is based primarily on the flow of a liquid suppurating wound or parietal drain. Urinary infection is confirmed by the urine culture. Furthermore, the postoperative endometritis is diagnosed on the basis of abdominal-pelvic pain, associated with smelly or purulent lochia.

Pathological samples are quickly transported to the microbiology laboratory within less than 90 minutes. Each sample must be accompanied by the demand
sheet comprising: first name, age, date and origin of the sample, clinical signs, presumptive diagnosis, and possible antibiotic treatment. Our study was conducted in the laboratory of Microbiology of the University Hospital of Constantine, during a period of three months from February to April, 2014. The analysis was carried out on 58 strains isolated from different pathological samples collected from women who have had caesarean section (one strain per patient). Culturing pathological products on usual media: cooked blood agar, Hektoen Enteric Agar, Chapman, nutrient agar in case of cytobacteriological examination of urine (CBEU) and selective media (cetrimide agar ...) allowed the isolation of the strains. The identification of bacteria was achieved by the conventional methods used in the laboratory, namely the study of their morphological, biochemical API cropping and galleries (analytical index profile). The detection of resistance phenotypes was studied by the conventional method of dissemination of antibiotic medium disks agar Mueller Hinton and reading and interpretation criteria recommended by the Clinical and Laboratory Standard Institute (CLSI). The demonstration of the production of β-lactamases with extended spectrum (ESBL) was achieved by the synergy test between clavulanic acid + amoxicillin and cephalosporins 3rd generation according to CLSI method. The image of synergy so-called champagne cork is characteristic of the presence of ESBL [3][17]. For detecting methicillin-resistant Staphylococcus sp, the technique used in our microbiology laboratory consisted in depositing a cefoxitin disk (30μ) on Mueller-Hinton medium inoculated with 10⁶ CFU / ml and then incubated 18 hours at 37°C. Staphylococcus negative coagulase: If the diameter of inhibition of cefoxitin ≤ 24 mm, the strain is called resistant to methicillin. For Staphylococcus aureus: if the diameter of cefoxitin is ≤ 19, the strain is called resistant oxacillin and is therefore (Meti R) [4][5].

**Results**

From a total of 58 pathological products received from the obstetrics and gynecology department during three months study period, 36 non-repetitive strains were isolated. The prevalence of post-operative infections is 62%. The sum of 26 parietal (pus), 6 vaginal and 4 urinary samples were studied. The vast majority of patients were between 30 and
40 years old. The decreasing distribution of isolated germs is *Escherichia coli* and *Staphylococcus* *sp* which were the most dominant bacteria with 22.22% and 19.44%, respectively; *Klebsiella pneumoniae*, *Streptococcus* *sp* with 11.11%; *Acinetobacter* *spp*, *Enterococcus* *spp*, *Morganella morganii* and yeast with 5.55% each and finally *Citrobacter diversus* with 2.77% (Figure 1).

**Fig 1:** Global Distribution of isolated maternity germs (post-operative) n = 36

The distribution of germs responsible for wound infections is dominated by Gram-positive bacteria with 50%, Gram negative bacteria with 46% and yeast with 3.84%. The distribution of the strains is as follows: *E.coli* with 19.3%, *Klebsiella pneumoniae*, *Morganella morganii* shows an identical percentage 7.69%. *Staphylococcus aureus* with 15.38%, *coagulase-negative Staphylococcus* with 11.53%, B group *Streptococcus* and *Enterococcus* *spp* with 7, 69% each, and finally the group A and C *Streptococcus* with 3.84% (Figure 2).
Fig 2: Distribution of germs responsible for wound infections

$n=26$

Regarding vaginal infections represented only by Enterobacteria and yeast, the distribution of germs is as follows: *Klebsiella pneumonia* with 50% *Escherichia coli* with 33.33% and finally yeast with 16.67% (Fig 3).

Fig 3: Distribution of germs that cause vaginal infections $n=6$

The distribution of germs involved in urinary infections indicates a high frequency of Enterobacteria with a 75% between *Escherichia coli* and *Klebsiella pneumonia* and *Staphylococcus* with 25%. ESBL producing strain were isolated, where 60% from the parietal samples and 40% from vaginal samples. *Klebsiella pneumonia* with four isolates and
Escherichia coli with one isolate. Klebsiella pneumoniae ESBL are 100% resistant to tobramycin and 25% are resistant to amikacin, in contrast to Escherichia coli ESBL strain remains sensitive to aminoglycosides and fluoroquinolones. The average rate of antibiotic resistance of all Enterobacteria is 50% for amoxicillin + clavulanate, it is 25% and 50% for Escherichia coli Klebsiella pneumoniae. The average rate of quinolone resistance of all strains of Enterobacteria is 38.89%, the rate specific to the strain Escherichia coli is 25%, it is 75% for the strain of Klebsiella pneumoniae. For this latter, resistance is associated with the secretion of ESBL in 25% of cases. Furthermore, over 55% of the isolated Enterobacteria are resistant to sulfamethaxazol + trimetoprim association. This resistance rate is 62.5% for Escherichia coli and Klebsiella pneumoniae. Overall, aminoglycosides are active on the Enterobacteria isolated with 5.56% of strains resistant to gentamicin, and 100% of susceptible strains to amikacin. Both isolated Acinetobacter spp strains are multi resistant and one of the two strains is resistant to ceftazidime and imipenem.

Table1. Antibiotic resistance profile of isolated strains of Enterobacteria n = 18

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>R</th>
<th>S</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin</td>
<td>15</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Amoxicillin + clavulanate</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Ticarcillin</td>
<td>13</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Piperacillin</td>
<td>10</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>11</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>1</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Cefotaxim</td>
<td>5</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Imipenem</td>
<td>0</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Gentamycin</td>
<td>1</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Amikacin</td>
<td>0</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>7</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Colistin</td>
<td>2</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Sulfamethoxazol+trimetoprim</td>
<td>10</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>
The rates of resistance of isolated *Staphylococcus aureus* are 100% to penicillin, 75% to oxacillin and cefotaxim, respectively; 25% to kanamycin, tobramycin and gentamycin; 100% to fosfomycin and 50% to erythromycin and lincomycin; 100% to the sulfamethaxazole + trimetoprim association, fusidic acid and vancomycin. In contrast, the strains are 100% sensitive to ciprofloxacin.

*Streptococcus spp* are 100% penicillin, amoxicillin, cefazolin and cefotaxime susceptible. The gentamycin and fosfomycin resistance is 100%; 75% to erythromycin and spiramycin. These strains are 100% resistant to lincomycin, however vancomycin and ciprofloxacin are still very active with 0% resistance.

The *enterococcus spp* isolated are resistant to cefazolin and cefoxitin. One strain is resistant to erythromycin and pristamycine. The two strains were susceptible to the rest of the tested antibiotics.

**Discussion**

The rate of cesarean delivery has increased during the last three decades. This elevation was accompanied by an increase in morbidity. In fact, several studies have shown that the overall incidence of nosocomial infections in women, who had C-section, is about 5 to 10 times higher than those who had birth by natural means [2][6]. Despite prophylaxis protocols to antibiotics currently recommended, at least 10% of overall cesarean are complicated by infection and more than 15% by fever [7]. These infections are associated with considerable economic charges. At the obstetrics and gynecology department of the University Hospital of Constantine the average length of stay duration for uninfected women who had caesarean was 4.1 days and the infected was 7.4 days. According to the administrative services of the University Hospital of Constantine, the average cost of non complicated cesarean surgical site infection is 20304 Algerian dinars (DA) and that of a complicated caesarean surgical site infection is 32092 DA ( DA = 0.01 €). Given the
rise in caesarean section rates, the prevention of post-caesarean infection remains a public health priority. Throughout the present study, 58 samples were collected among which 36 cases (62%) of infectious complications have been found. The parietal infections (SSI) are the most frequent with a rate of 72% followed by vaginal infections with 16.66% and finally urinary tract infections with a rate of 11%.

The strains are largely dominated by Enterobacteria (n = 18) 50%, headed by Escherichia coli, gram-positive cocci with a frequency of 38.89% with a predominance of Staphylococcus aureus and coagulase-negative Staphylococcus. The distribution of germs in the samples shows that among the 26 parietal performed, Gram positive cocci predominated with 50% of the isolates (Staphylococci with 26.91% and Streptococci with 15.38%). The Enterobacteria with 38.46% (E.coli with 19.3%, Klebsiella and Morganella with 7.69%; Citrobacter with 3.84%) and finally Acinetobacter spp, and one yeast. Our results differ from those of [8] indicating a predominance of Enterobacteria in the parietal samples. In many studies Staphylococcus aureus is the main cause of (SSI) followed by different species of Enterobacteria and Pseudomonas aeruginosa [9] [10]. However, [11] in Dakar observed a strong predominance of Pseudomonas aeruginosa. This difference in the distribution of bacterial species, appear to be related to the microbial ecology of the hospital. Among the 6 vaginal performed samples, Klebsiella pneumoniae predominates with a frequency of 50%, followed by E.coli with 33.33 and yeast with 16.67%. According to the literature, the germs causing vaginal infections are usually from maternal vaginal flora. E.coli is the most common germ in 4-13% of cases. All the negative Gram aero-anaerobic (Klebsiella, Proteus mirabilis, Enterobacter) were found in 10-20% of cases and anaerobes in 45% of cases [12]. It is generally accepted that vaginal flora plays a central role in the development of post-caesarean infections [13]. Within 4 urine samples taken; all the isolated bacteria are NGB, Klebsiella pneumoniae appears to be the most dominant species with a rate of 50%, followed by E. coli 25%.
Regarding antibiotic resistance, Enterobacteria isolated in the present study showed a significant resistance to β-lactamines. Indeed more than 50% of strains of *E. coli* were resistant to amoxicillin and ticarcillin. This resistance is corrected by the addition of clavulanic acid, which gives 75% sensitivity. For cephalosporins, 25% resistance is noted for cefazolin, cefotaxim 12.5%, imipenem remain effective with 100% sensitivity, and this result was confirmed by [14] in 2005. The aminoglycosides also have a good activity, with 100% sensitivity towards gentamicin, and amikacin. For quinolones, strains of *E. coli* were resistant to 25% to nalidixic acid; the rate was far from that of [15] who reported 8.3% resistance.

A major resistance of 62.5% was noted for trimethoprim-sulfaméthaxazol association, this result was far away from that of Aissi and *al* in 2007[16] reporting a 43% resistance to this association.

Regarding all *Klebsiella pneumoniae* isolates were 100% resistant to amoxicillin (natural resistance), however 50% of strains from different samples were resistant to amoxicillin-clavulanic acid association, a phenomenon related to the production of TRI type β-lactamases.

Imipenem exhibited a strong activity on the strains of *Klebsiella pneumoniae*, this activity was not affected by the strains producing β-lactamases [14] [17].

During our study two wild strains of *Morganella morganii* were isolated, they are savage.

The *citrobacter* are essentially hospital bacteria. The only isolated strain of *Citrobacter diversus* has exhibited resistance to β-lactam antibiotics; however, it remained sensitive to quinolones and aminoglycosides.

The *Acinetobacter spp* is a saprophyte germ widespread in nature [18], these bacteria may be present in the operating sites and infecting women who had caesarean, thus, colonizing the skin. The two isolated strains were resistant to β-lactamines but susceptible to colistin. One of the two strains was resistant to imipenem and ciprofloxacin. The resistance to imipenem reported as alarming, is related to the inadequate use of this antibiotic and the persistent power of *Acinetobacter* in hostile environments, the ability to live in community (biofilms) and plasmid
exchange, which make this type of bacterium a growing multidrug resistance bacterium according to many authors [19] [20].

In addition to the GNB, Gram positive cocci have an important part in post-caesarean infections. The *Staphylococcus aureus* strains isolated in our study show almost total resistance to penicillin similarly to those reported by other authors [21] [8]. This inefficiency may be due to the secretion of penicillinase which is a plasmid enzyme that hydrolyses penicillin [22].

A resistance of 75% is noted for oxacillin, *Staphylococcus aureus* has a notable ability to acquire resistance to antibiotics, and methicillin resistance represents a growing public health problem. Methicillin-resistant *S. aureus* (MRSA) has also become significant outside the hospital environment, particularly in the United States. In Brazil, since 2005, cases of skin infections community Caused by MRSA have been reported, involving outpatients purpose resistance studies are scarce [23].

The oxacillin resistance is an intrinsic resistance, in our study 3 over 4 isolated strains showed resistance to oxacillin (Meti-R), this high proportion evoke a hospital origin of these strains.

Concerning aminoglycosides, 25% of resistance is registered to kanamycin, tobramycin and gentamicin, respectively. [24] in 2010 reported a rate of only 10.1% in Morocco.

Resistances of *Staphylococcus aureus* to aminoglycosides are due to the production of modifying enzymes of the aminoglycosides, encoded by acquired plasmid genes [25].

Vancomycin is very active; a result confirmed by the work of [24] [8] and it remains the drug of first choice in the treatment of MRSA infections.

*Streptococci* are also part of the bacteria that infect women who had caesarean and have a crucial place in pathology. Their resistance to antibiotics is increasing [26].

The β-lactamines had generally a good activity on the strains isolated in our study; a similar result was obtained by [27] in Senegal. The parietal structure of *Streptococcus* does not object to prevent the distribution of β-lactamamines and it has not yet been described any β-lactamases in these
bacteria [26]. Isolated Streptococci are 100% resistant to gentamycin whereas the literature reported various resistance rates: 60% by [28] in 2004 and 6% by [29] in 2007. For erythromycin, 75% is noted compared to a value of 50% reported by [30]. Both isolated Enterococcus spp strains were susceptible to amoxicillin but resistant to cephalosporins, however, they are susceptible to ciprofloxacin, considered as the treatment of choice for women with post-cesarean infectious complications.

**Conclusion**

Analysis of the results of the present study demonstrated that the C-section should not be considered an easy option because it is not devoided of morbid maternal complications and can be fatal. The diagnosis of these post-cesarean infections in our hospital structure has identified the main germs in question. A better identification of predisposing factors and their prevention could reduce significantly the post-cesarean infectious complications, as prevention is the best way to fight, and therefore improve maternal prognosis. This prevention is based on respect for hygiene, personal and collective cleanliness of the hospital environment (buildings, medical devices, hospital staff, patients and visitors) and a more appropriate antibiotic therapy.

**REFERENCES**

5- Standardization of antimicrobial susceptibility testing in human medicine nationwide, according to WHO 2011.

7- F Smail, GJ Hofmeyer, Antibiostatic prophylaxis for cezarean section. *Cochrane Database System rev*, (3): CD000933, 2002


14- R Seck, Résistance des souches d’*Escherichia coli* et *Klebsiella pneumoniae* isolées d’infections urinaires, Thèse de doctorat en pharmacie. Université Cheikh Anta Diop de Dakar, 50-55, 2005

15- A Ferjani, M Marzouk, F Ben Moussa, J Boukadida, Résistance des souches d’*E.coli* isolées de prélèvements d’origine urinaire vis-à-vis de l’association amoxicilline-acide clavulanium et divers antibiotiques. *J Med Mal Inf* 06.007, 2009


21- N Aujjar, B Attarassi, N Alhaloui, A Badoc, Multi résistance aux antibiotiques de *Pseudomonas aeruginosa*, *Pseudomonas fluorescens* et *Staphylococcus


