

Citric acid treatment of post-caesarean wound infections caused by multiple antibiotic-resistant *Staphylococcus aureus*

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ABSTRACT

Post-caesarean wound infections are difficult to manage, especially when they are caused by multiple antibiotic-resistant *Staphylococcus aureus*. An attempt was made to treat post-caesarean staphylococcal wound infections with topical application of citric acid. Twenty post-caesarean patients with wound infections caused by multiple antibiotic-resistant *S. aureus* were treated by application of 3% citric acid once daily. Wound dressing with citric acid ointment in 18 cases resulted in complete healing after 6 to 21 applications. Topical application of citric acid was found highly effective in the treatment of post-caesarean wound infections due to multiple antibiotic-resistant *S. aureus*.

Keywords: Lower segment caesarean section, wound infections, *S. aureus*, citric acid.

INTRODUCTION

Lower segment caesarean section (LSCS) is the single greatest risk factor for postpartum infection in developing countries. Women undergoing LSCS have a five to 20-fold greater risk of infection and infectious morbidity. Infectious complications following LSCS are an important cause of maternal morbidity. Post-caesarean wound infection (wound dehiscence) is one of the most important and common complications. The worldwide rate of wound infections following LSCS ranges between 3% and 15%¹⁻³. However, the rate of infection in India ranges between 4% and 9%^{4,5}. Wound infections following LSCS are the leading causes of maternal morbidity, prolonged hospital stay and increased health care costs, and continues to be a common postoperative complication in both the developed and developing world⁶⁻⁸.

Post-caesarean wound infections are caused by *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella* spp., *Proteus* spp., et cetera. Among these bacterial pathogens, *S. aureus* is the most common pathogen associated with post-caesarean wound infections. These infections are difficult to manage, especially when they are caused by multiple antibiotic-resistant strains of *S. aureus*^{7,9}.

Citric acid, a natural product obtained from citrus fruits, has been used as a topical agent for the treatment of a variety of wound infections caused by multiple antibiotic-resistant strains of *P. aeruginosa* and *E. coli*^{10,11}. In the present study, an attempt has been made to treat post-caesarean wound infections caused by multiple antibiotic-resistant strains of *S. aureus* refractory to conventional oral or injectable antibiotic therapy and local wound care (using irrigation with hydrogen peroxide and dressing with betadine) by using topical application of 3% citric acid ointment.

MATERIAL AND METHODS

A prospective open study on post-caesarean wounds infected with multiple antibiotic-resistant strains of *S. aureus* was carried out. The study protocol was approved by the institutional ethical committee of MIMSR Medical College, Latur, India (MIMSR EC1/97) and informed consent was taken from the patients who participated in the study.

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A total of 20 females in the age group of 20–40 years who developed wound dehiscence in the range of 2.5 cm to 7 cm following LSCS and post-caesarean wound infections with multiple antibiotic-resistant strains of *S. aureus* in significant number on pus culture and not responding to conventional treatment with injectable or oral antibiotic/s and local wound care (hydrogen peroxide + betadine) were selected for the study.

The identity of *S. aureus* isolates from pus culture was confirmed by standard culture techniques, that is to say, specimen of pus was inoculated on blood agar and MacConkey agar. The colonies grown after overnight incubation at 37°C were confirmed using standard biochemical reactions¹². The isolates of *S. aureus* were subjected to antibiotic susceptibility testing by the Kirby-Bauer disc diffusion method using ampicillin (10 µg), amikacin (30 µg), cefoxitin (30 µg), ceftazidime (30 µg), ciprofloxacin (5 µg), clindamycin (2 µg), linezolid (30 µg) and netillin (30 µg)¹³. The isolates of *S. aureus* were also tested for minimum inhibitory concentration (MIC) against citric acid by broth dilution method.

All 20 cases with their consent were selected for topical application of 3% citric acid ointment. Three percent citric acid ointment was prepared by mechanical mixing of citric acid with 100% pure petroleum jelly as a base in a mortar and used for wound dressing. The wounds were surgically debrided to remove necrotic material before initiating the application of citric acid ointment, and then were irrigated and cleaned with normal saline. After this, citric acid was filled in wound dehiscence and dressed with a sterile pad. This treatment modality was used once daily until the wound healed completely or showed formation of healthy granulation tissue. The large wounds showing healthy granulation tissue were closed by suturing. The patients were called for follow-up after one week. No antibiotics were given during the course of this treatment.

RESULTS

In vitro antibiotic susceptibility studies showed that out of 20 isolates, six (30%) were found to be resistant to all antibiotics tested against them. A total of 18 isolates (90%) were found to be methicillin-resistant *S. aureus*. Linezolid (30%) was found to be the most effective agent may be because of less exposure of *S. aureus* to this special reserved antibiotic, which is not much in use in India. No isolate was found to be susceptible to ampicillin and ciprofloxacin (Table 1). All the isolates of *S. aureus* were found to be inhibited by citric acid. The MIC to citric acid was found in the range of 900–1000 µg/ml of citric acid. Wound dressing with 3% citric acid ointment in 18 cases (90%) resulted in complete healing in 7 to 21 applications, whereas in two cases, in which wound dehiscence was very large, result was formation of healthy granulation. The number of cases and applications required for wound healing are shown in Graph 1. In two cases, wounds were closed by suturing. No adverse effects were noted in any of the patients, except for mild to moderate skin

Table 1: Antibiotic susceptibility pattern of *S. aureus* isolates

Sr. No.	Antibiotic	No. of susceptible isolates (n=20)	Percentage
1.	Amikacin	02	10
2.	Ampicillin	00	00
3.	Cefoxitin	02	10
4.	Ceftazidime	02	10
5.	Ciprofloxacin	00	00
6.	Clindamycin	02	10
7.	Linezolid	06	30
8.	Netillin	02	10

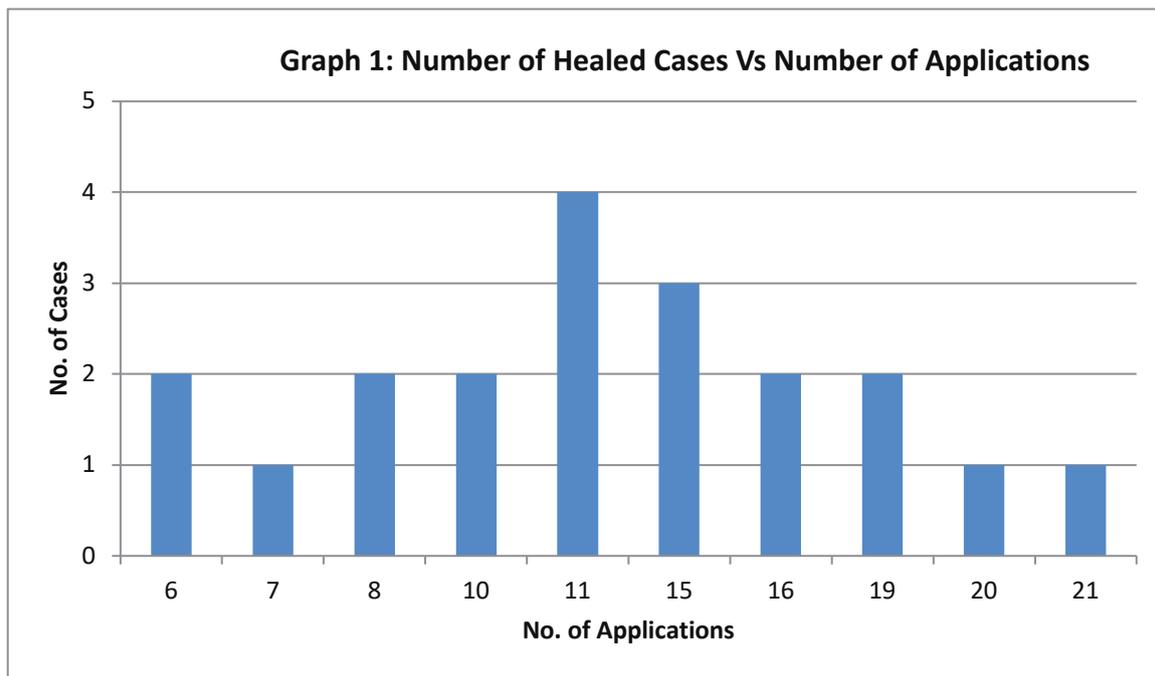
irritation in some patients. The follow-up of these cases after one week showed no signs of infections.

DISCUSSION

Wound healing is a natural process and is taken for granted when the host–bacterium equilibrium is in balance. However, the presence of bacteria and bacterial products disturbing the host–bacterium equilibrium can cause disturbances in the normal phases of wound healing by affecting each and every phase in healing process. Thus, infection is the leading cause of non-healing of a wound. The higher levels of bacteria at a wound site prevent a timely and orderly healing trajectory. The healing, however, can be enhanced by reducing the bacterial burden¹⁴.

Although reduction of bacterial burden enhances the process of healing, it is quite difficult to reduce/eliminate bacterium from infected wounds, especially the multiple antibiotic-resistant bacteria that need special attention, and which, if not controlled, may become life-threatening. A number of experimental studies both *in vitro* and in animal wounds suggest that almost all antiseptic agents routinely used for local wound care may be toxic to the cells involved in the wound healing process and interfere with normal wound healing process^{15,16}. The high levels of antibiotic present in the blood at the time of wounding clearly diminish, but do not eliminate wound infections. Antibiotics present in the blood at the time of injury are trapped in the fibrin clot, where they exert their effect, but when given later, they diffuse poorly into clotted fibrin and have little effect on bacteria present in the wound^{17,18}.

In view of these problems, we initiated the use of citric acid for the effective treatment of wounds infected with a variety of bacteria, including multiple antibiotic-resistant strains^{10,11}. Citric acid in a concentration of 3–5% has been reported to be highly effective in the treatment of infected wounds in animals¹⁹ and a concentration of 3% citric acid has been



Note: In two cases with large wound dehiscence, healthy granulation tissue was formed after six applications

found optimum as far as its efficacy in the treatment of wound infections and adverse effects in the form of irritation are concerned²⁰⁻²³. Our earlier experience shows that the use of citric acid in a concentration of 3–5% is known to cause no adverse effects except for mild to severe irritation. It has been found to cause severe irritation in cases of venous ulcers and superficial burns and mild to moderate irritation in deep burns and traumatic wounds in non-diabetic individuals. In the present study, topical application of 3% citric acid ointment in all 20 cases was found effective in the successful elimination of multiple antibiotic-resistant *S. aureus*, which are otherwise very difficult to eliminate from the infection site, and successful healing of wounds without any adverse effects. This preparation of 3% citric acid prepared by triturating 3 g of citric acid in 100 g of petroleum jelly differs from RescuDerm™ in composition as well as its efficacy. The RescuDerm™ is an amorphous, organic acid-based gel containing a mixture of organic acids — acetic acid, citric acid and ethylenediaminetetraacetic acid (EDTA). However, citric acid is the only organic acid used in our study in a concentration of 3% against the concentration of 4% in a RescuDerm™. When considering efficacy also, the citric acid, as a single agent, was found more effective than RescuDerm™ containing a mixture of three different organic acids effective against marginally or moderately contaminated cutaneous wounds and comparatively less effective against heavily contaminated wounds^{24,25}.

CONCLUSION

The results of the present study suggest that citric acid is effective in the successful elimination/reduction of burden of

S. aureus, including multiple antibiotic-resistant strains and proves to be an effective alternative for the successful clinical management of post-caesarean wound infections caused by multiple antibiotic-resistant *S. aureus*. Citric acid could be useful in the prevention of post-operative wound colonisation with potential pathogens, if used as a dressing agent instead of conventional antiseptic agents since the time of operation in post-operative period. Future studies involving control group (randomised control trials) will help to achieve more useful and concrete conclusions.

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None.

CONFLICT OF INTEREST

None.

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