

Antibacterial Effect of Octylcyanoacrylate against Methicillin-resistant *Staphylococcus aureus* Isolates from Patients with Chronic Suppurative Otitis Media

CHUL HO JANG^{1,2}, HAEKYUN PARK³, CHEOL HEE CHOI², YONG BUM CHO¹ and IL YONG PARK⁴

¹Department of Otolaryngology, Chonnam National University Medical School, Gwangju;

²Research Center for Resistant Cell and ³Department of Biology, Chosun University Gwangju;

⁴Department of Biomedical Engineering, Dankook Medical School, Cheonan, South Korea

Abstract. *There has been a steady increase in the number of cases of methicillin-resistant Staphylococcus aureus (MRSA) otorrhea; this is a growing medical concern. For otological surgery in children, octylcyanoacrylate can be an alternative method of closure for surgical incisions. Recent in vitro studies have shown that octylcyanoacrylate is effective as an antimicrobial barrier. To date, there have been only rare reports on the antibacterial effect of octylcyanoacrylate against MRSA. The purpose of this study is to determine the antimicrobial effects of octylcyanoacrylate against the MRSA that was isolated from patients with chronic suppurative otitis media. Materials and Methods: Clinical MRSA (n=20) bacteria and methicillin-sensitive SA (MSSA) (n=20) were obtained from patients. The susceptibilities to various antibiotics were determined by disk diffusion method. Results: MSSA was sensitive to octylcyanoacrylate. The antibacterial activity of octylcyanoacrylate was weak against MRSA. Conclusion: Our results demonstrated that octylcyanoacrylate has slight antibacterial activity against MRSA.*

Tissue adhesives are a class of compounds that are known as cyanoacrylates and can bind to skin surfaces via a polymerization reaction. Tissue adhesives have good tensile strength, are bactericidal and bacteriostatic, have negligible histotoxicity and they peel off spontaneously (1, 2). Octylcyanoacrylates are a newly introduced generation of tissue adhesives. Octylcyanoacrylates have been designed to overcome the shortcomings of butylcyanoacrylates: they form

a stronger and more flexible bond, their breaking strength is three to four times higher than that of butylcyanoacrylates and is comparable to that of a 5/0 monofilament suture (3). For otological surgery in children, octylcyanoacrylate can be an alternative method of closure for surgical incisions. Several comparative studies involving low-tension wounds of the face have shown that tissue adhesives provide a cosmetic outcome comparable to that of suturing both at 2 months and at the 1-year follow-up, while they cause less pain as measured on a visual analogue scale (4) and require less time for completion of the procedure (1, 2, 5, 6).

The most common hospital infections in surgical patients are surgical-site infections. *Staphylococcus aureus* carriage usually involves the nose and skin. The relationship between nasal and skin colonization with subsequent infection has been well established by Suh *et al.* (7). They found an increased number of patients with surgical-site infection following middle ear surgery. During the past 20 years, methicillin-resistant *S. aureus* (MRSA) has become an important source of these infections and it is presently responsible for up to 61% of all *Staphylococcus* infections (8-10). There are considerable treatment difficulties and complications with MRSA infection due to its resistance to the available antibiotics such as cloxacillin, oxacillin, nafcillin and cephalosporin, in addition to methicillin. There has been a steady increase in the number of cases of MRSA otorrhea and this is a growing medical concern (11). Concern has recently emerged regarding the increasing incidence of community-acquired MRSA infections that present in pediatric otitis media patients with otorrhea (8, 12).

Recent *in vitro* studies have shown that octylcyanoacrylate is effective as an antimicrobial barrier for the first 72 h after application. The skin formed by octylcyanoacrylate is effective against gram-positive and gram-negative bacteria. Cyanoacrylates have also been shown to have antimicrobial properties (13, 14). To date, there are only rare reports on the antibacterial effect of octylcyanoacrylate against MRSA. The purpose of this study was to determine antimicrobial

Correspondence to: Chul Ho Jang, Department of Otolaryngology, Chonnam National University Hospital, Hakdong 8, Dongku, Gwangju, South Korea. Tel: +82 62 2206774, e-mail: chulsavio@hanmail.net

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Table I. Antibacterial effect of octylcyanoacrylate compared to antibiotics.

	Vancomycin	Ceftazidime	PT	Octylcyanoacrylate
MSSA	5 +	4 +	4 +	1 +
MRSA	2 +	-	-	1 +

-, no inhibition; 1+, <3 mm zone of inhibition; 2+, 3-5 mm; 3+, 5-7 mm; 4+, 7-10 mm; 5+, <10 mm. PT, piperacillin-tazobactam; MSSA, methicillin-sensitive *Staphylococcus aureus*; MRSA, methicillin-resistant *Staphylococcus aureus*.

effects of octyl-cyanoacrylate against the MRSA that was isolated from patients with chronic suppurative otitis media.

Materials and Methods

The bacterial cultures used in this study were obtained from the otorrhea in chronic suppurative otitis media (CSOM) patients. Clinical MRSA (n=20) bacteria and MSSA bacteria (n=20) were obtained from the patients at the Chonnam National University Hospital in Gwangju city, South Korea (March 2006 through May 2007). The susceptibilities to various antibiotics were determined by disk diffusion method according to the guidelines of the Clinical Laboratory Standards Institute (15). Bacterial inoculates were seeded on plates containing Muller-Hinton medium for the MRSA and MSSA. All the bacteria were seeded. After inoculation, a small filter paper impregnated with 20 µl (64 µg/ml) of antibiotics or 20 µl of octylcyanoacrylate were gently pressed and evenly distributed on the agar plates. The tested antibiotics were vancomycin (SamjinPharm. Co., Seoul, South Korea), ceftazidime (KunhwaPharm. Co.) and piperacillin-tazobactam (Tazocin; Weith Korea, Inc., Seoul, South Korea). The plates were incubated overnight. The antibacterial activity was then assessed by sampling the inhibition zones when they were present. The inhibition zones were measured by virtue of the difference in contrast between the bacterial lawn and that surrounding the disk or well where the bacterial growth had been prevented.

Results

Table I shows the mean size of all the inhibition zones on the study plates. MSSA was sensitive to octylcyanoacrylate (Figure 1A). Although the antibacterial activity of octylcyanoacrylate was far less than that of vancomycin, it showed slight antibacterial activity against MRSA (Figure 1B). Tazocin and ceftazidime did not show any antibacterial activity against MRSA; they showed antibacterial activity only against MSSA.

Discussion

This study shows the antibacterial effect of octylcyanoacrylate against the MSSA and MRSA that were isolated from CSOM patients. The antibacterial effect of octylcyanoacrylate against MRSA was greater than that of ceftazidime and piperacillin-

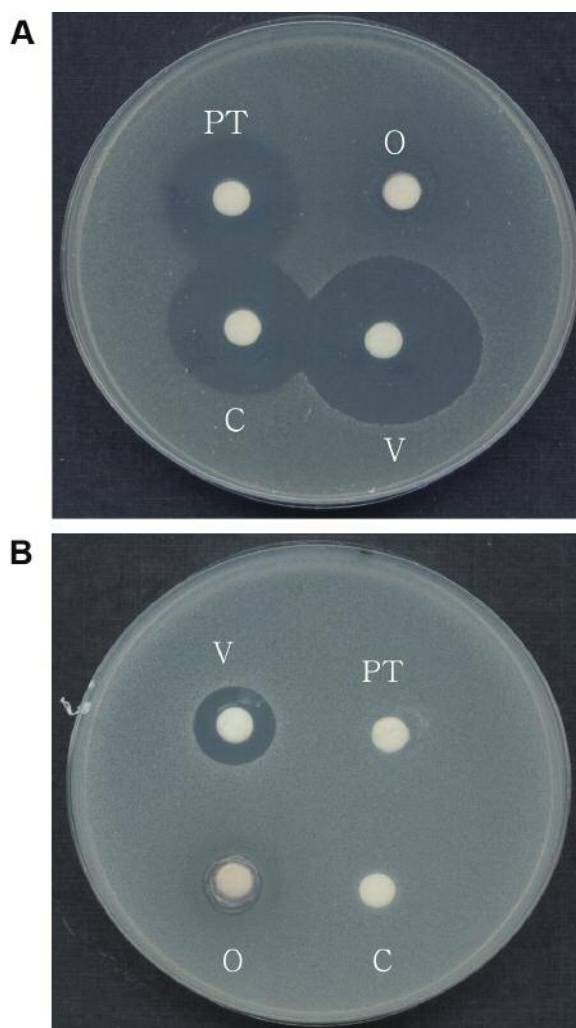


Figure 1. The susceptibilities to antibiotics and octylcyanoacrylate were determined for methicillin-sensitive (A) and methicillin-resistant *Staphylococcus aureus* (B) by disk diffusion method. MSSA: methicillin-sensitive *Staphylococcus aureus*, MRSA: methicillin-resistant *Staphylococcus aureus*, O: octyl-cyanoacrylate, V: vancomycin, C: ceftazidime, PT: piperacillin-tazobactam.

tazobactam. The antibacterial effect of cyanoacrylate varies according to the speed of degradation (16, 17). *In vitro* studies have shown that cyanoacrylate homologues are increasingly bacteriotoxic in order of their decreasing chain length (16).

The exact mechanism of the antimicrobial effect of cyanoacrylate is unclear, but it is likely to be a cell wall mechanism because the sensitivities are restricted to gram-positive organisms. A possible explanation could be the strong electronegative charge on the polymer that could react with the cell wall of gram-positive organisms which has a positive charge. The gram-negative organisms would be relatively unaffected because of their lipopolysaccharide membrane, which insulates the cell wall (13). To the best of

our knowledge, this is the first study on the antibacterial activity of octylcyanoacrylate against the MRSA that was isolated from the otorrhea in patients with chronic suppurative otitis media.

Cyanoacrylates work *via* an exothermic polymerization reaction that forms a strong bond within minutes after contact with a fluid or basic medium (18). This technology immediately became popular in multiple surgical specialties, but it is especially attractive to paediatric surgeons due to the speed of application. The advantages of octylcyanoacrylate compared with suture include its ease of use, faster application, the decreased pain, wound care is reduced because it serves as its own barrier dressing and, since it spontaneously falls off, no follow-up is required for removal. For otologic surgery in children, octylcyanoacrylate can be an alternative method of closure for surgical incisions. However, there are scarce reports in the literature on the antibacterial effect of octylcyanoacrylate against MRSA. Further studies are necessary to determine the antibacterial effect of octylcyanoacrylate against MRSA using a wound infection model.

Conclusion

Our results showed that octylcyanoacrylate has slight antibacterial activity against MRSA. Further *in vivo* studies are necessary to confirm the antibacterial effect of octylcyanoacrylate against MRSA.

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