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Antibiotic-coated pins for prevention of pin-tract infection: a rabbit study

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ABSTRACT

Purpose. To evaluate the efficacy of antibiotic-coated pins for prevention of pin tract infection in a rabbit model.

Methods. 10 rabbits were divided into 2 groups. A unilateral external fixator was applied to the tibia with 4 self-taping 1.8-mm pins. In the test group, pins were coated with hydroxyapatite and antibiotic. In the control group, pins were not coated. All pins were then placed in *Staphylococcus aureus*–containing media. At postoperative day 5, all 40 pin sites were subcutaneously inoculated with *S aureus*. The sites were clinically examined for signs of pin tract infection. Nine days later, a piece of soft tissue around the pin site was harvested for microbiologic examination.

Results. In the test group, all except one pin sites appeared clean and without clinical infection, and the culture media remained clear. In the control group, all pin sites showed evidence of clinical infection and yielded positive cultures, and the culture media became dark indicating growth of *S aureus*.

Conclusion. Antibiotic-coated pins were effective in preventing pin tract infection.

Key words: *anti-bacterial agents; external fixators; surgical wound infection*

INTRODUCTION

External fixators are widely used for treatment of comminuted fractures, open fractures, osteomyelitis, nonunion or pseudoarthrosis, lower-extremity deformities, limb length inequality, and arthrodesis. Complications of external fixators include pin tract infections, pin loosening, pin irritation, pin/wire breakage, malunion, delayed union, non-union, joint contracture/subluxation, wound dehiscence, osteomyelitis, and compartment syndrome.[1,2] Among these, pin tract infection is the most common problem during limb lengthening involving external fixation.[3] The rates of pin tract infection vary,[4–10] and can be as high as 95%.[4] Minor inflammation or superficial infection is usually treated with

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antibiotics, local wound care, and occasionally, pin removal. Osteomyelitis warrants operation and sequestrectomy.[4,10] Pin tract infections can affect the stability of fixation. This study evaluated the efficacy of antibiotic-coated pins for prevention of pin tract infection after external fixation.

MATERIALS AND METHODS

The protocol of animal experiments was approved by the local animal protection agency and the ethics committee of the hospital. 10 white male rabbits weighing 1.2 to 1.5 kg were divided into 2 groups. All rabbits were anaesthetised by intravenous ketamine hydrochloride (20 mg/kg) and xylazine (5 mg/kg) of their body weight. The tibia was drilled using a 1.5-mm Kirschner wire. An osteotomy was created between the second and third pins using a fine wire saw (Fig. 1). A unilateral external fixator (Orthofix M-100) was applied to the tibia with 4 self-taping 1.8-mm pins.

Figure 1 Subperiosteal osteotomy of the tibia.

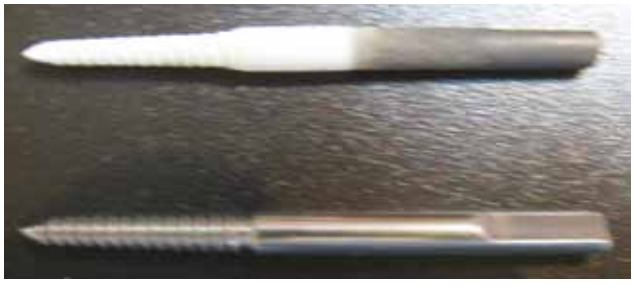

Figure 2 Half pins with and without hydroxyapitate and antibiotic coating.

In the test group, pins were coated with hydroxyapatite and antibiotic (Fig. 2). 10 g of hydroxyapatite in 30 to 50 μm thick was applied by a Plasma-Technik A-3000S. The pins were then placed in 5 g of vancomycin solution for 48 hours. In the control group, pins were not coated. All pins were then placed in *Staphylococcus aureus*–containing media.

On postoperative day 5, all 40 pin sites were subcutaneously injected with 1 ml of bacterial suspension containing $3x10^6$ colony-forming units of *Staphylococcus aureus* (ATCC 29213). The sites were clinically examined for signs of pin tract infection every day. Nine days later, a piece of soft tissue around the pin sites was harvested for microbiologic examination (gram staining and culture in general and selective media). The 2 groups were compared using the Mann-Whitney *U* test with Monte Carlo sig (2-tailed). A p value of <0.05 was considered statistically significant.

RESULTS

In the test group, all except one pin sites appeared clean and without clinical infection, and the culture media remained clear. In the control group, all pin sites showed evidence of clinical infection and positive cultures. The difference between the 2 groups was significant ($p<0.005$, Table), and the culture media became dark indicating the growth of *S aureus* (Fig. 3).

DISCUSSION

In pin tract infection, the most common organisms are gram-positive bacteria (*S epidermidis* and *S aureus*), followed by *Escherichia coli*.[5] These organisms

Table
Clinical and microbiological evidence of infection in the 2 groups

Rabbit no.	Purulent drainage at pin site		Colony-forming unit		Culture positive	
	Test group	Control group	Test group	Control group	Test group	Control group
1	No	Yes	0	3 600 000	No	Yes
2	No	Yes	0	2 500 000	No	Yes
3	No	Yes	0	3 000 000	No	Yes
4	No	Yes	0	6 500 000	No	Yes
5	No	Yes	3 000 000	6 500 000	Yes	Yes

Figure 3 **(a)** Non-infected smear and **(b)** infected smear.

usually grow in biofilms around the implant,[11] which is associated with the chronic nature of the subsequent infections and inherent resistance to antibiotic chemotherapy.[12] Systemic administration of antibiotics may have side-effects and prolong hospitalisation. Application of local antibiotics to prevent pin tract infection is preferred. Silver-coated pins and stainless steel pins have no detectable difference in the rates of pin tract infection.[13] Gentamycin-coated polyurethane sleeves fitted over the pins enable higher concentrations of antibiotics in the pin tract for at least 20 weeks.[14] This higher level of local antibiotic can prevent colonisation of infecting organisms around external fixator pins.[14] Lipid-stabilised hydroxyapatite/chlorhexidine coating for external fixator pins resulted in lower rates of pin tract infection.[15] The poly(D,L-lactic acid) coating thickness affects *in vitro* vancomycin release from a hydroxyapatite carrier.[16]

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES

1. Richards JE, Magill M, Tressler MA, Shuler FD, Kregor PJ, Obremskey WT, et al. External fixation versus ORIF for distal intra-articular tibia fractures. Orthopedics 2012;35:e862–7.
2. Hsu LP, Schwartz EG, Kalainov DM, Chen F, Makowiec RL. Complications of K-wire fixation in procedures involving the hand and wrist. J Hand Surg Am 2011;36:610–6.
3. Eldridge JC, Bell DF. Problems with substantial limb lengthening. Orthop Clin North Am 1991;22:625–31.
4. Antoci V, Ono CM, Antoci V Jr, Raney EM. Pin-tract infection during limb lengthening using external fixation. Am J Orthop (Belle Mead NJ) 2008;37:E150–4.
5. Mahan J, Seligson D, Henry SL, Hynes P, Dobbins J. Factors in pin tract infections. Orthopedics 1991;14:305–8.
6. Marsh JL, Nepola JV, Wuest TK, Osteen D, Cox K, Oppenheim W. Unilateral external fixation until healing with the dynamic axial fixator for severe open tibial fractures. J Orthop Trauma 1991;5:341–8.
7. Marsh JL, Smith ST, Do TT. External fixation and limited internal fixation for complex fractures of the tibial plateau. J Bone Joint Surg Am 1995;77:661–73.
8. Respet PJ, Kleinman PG, Meinhard BP. Pin tract infections: a canine model. J Orthop Res 1987;5:600–3.
9. Marsh JL, Bonar S, Nepola JV, Decoster TA, Hurwitz SR. Use of an articulated external fixator for fractures of the tibial plafond. J Bone Joint Surg Am 1995;77:1498–509.
10. Egol KA, Paksima N, Puopolo S, Klugman J, Hiebert R, Koval KJ. Treatment of external fixation pins about the wrist: a prospective, randomized trial. J Bone Joint Surg Am 2006;88:349–54.
11. Trampuz A, Osmon DR, Hanssen AD, Steckelberg JM, Patel R. Molecular and antibiofilm approaches to prosthetic joint infection. Clin Orthop Relat Res 2003;414:69–88.
12. Stewart PS, Costerton JW. Antibiotic resistance of bacteria in biofilms. Lancet 2001;358:135–8.
13. Coester LM, Nepola JV, Allen J, March JL. The effects of silver coated external fixation pins. Iowa Orthop J 2006;26:48–53.
14. Forster H, Marotta JS, Heseltine K, Milner R, Jani S. Bactericidal activity of antimicrobial coated polyurethane sleeves for external fixation pins. J Orthop Res 2004;22:671–7.
15. DeJong ES, DeBerardino TM, Brooks DE, Nelson BJ, Campbell AA, Bottoni CR, et al. Antimicrobial efficacy of external fixator pins coated with a lipid stabilized hydroxyapatite/chlorhexidine complex to prevent pin tract infection in a goat model. J Trauma 2001;50:1008–14.
16. Ravelingien M, Mullens S, Luyten J, D'Hondt M, Boonen J, De Spiegeleer B, et al. Vancomycin release from poly(D,L-lactic acid) spray-coated hydroxyapatite fibers. Eur J Pharm Biopharm 2010;76:366–70.