

TREATMENT OF A SOLE ABSCESS IN AN ASIAN ELEPHANT (*ELEPHAS MAXIMUS*) USING REGIONAL DIGITAL INTRAVENOUS PERFUSION

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Abstract: Regional digital i.v. perfusion was used to treat a severe sole abscess associated with a wire foreign body in a 19-yr-old female Asian elephant (*Elephas maximus*) housed at the Paris Zoo. The cow presented with acute right forelimb lameness and swelling that persisted despite 4 days of anti-inflammatory therapy. Under anesthesia, a 10- × 0.5- × 0.5-cm wire was extracted from the sole of the right foot. There was a 2-cm-deep, 7-cm-diameter abscess pocket that was subsequently debrided. Regional digital i.v. perfusion was performed and repeated 15 days later, using cefoxitin and gentamicin on both occasions. Between treatments, the cow received trimethoprim-sulfamethoxazole and phenylbutazone orally. Within 2 days of administering anesthesia and the first perfusion treatment, the lameness improved dramatically. When phenylbutazone was discontinued 1 wk after the first treatment, the lameness had completely resolved. At the second treatment, there was no evidence of further soft tissue infection, and the abscess pocket had resolved.

Key words: Asian elephant, *Elephas maximus*, sole, abscess, regional digital intravenous perfusion.

INTRODUCTION

The Paris Zoo has housed Asian elephants (*Elephas maximus*) for many years in a no-contact system because of safety concerns, facility design, and behavioral studies. The facility does not include a crush restraint system, and anesthesia is necessary for hands-on medical care. Treatment of elephant foot-related problems has been problematic, as daily foot care is not possible. In 1997, a male elephant at the zoo was euthanatized for severe, bilateral nail abscesses of the forelegs despite repeated treatments under anesthesia.

Recently, regional digital i.v. perfusion was used in an African elephant (*Loxodonta africana*) with chronic pedal osteomyelitis on left forelimb.¹³ That elephant was managed in a free-contact setting and could be treated daily. Although the treatments were repeated frequently in the African elephant, the i.v. perfusion technique was originally described for one-time therapy of osteomyelitis in domestic animals, including cows and rabbits.^{1,2,6,11,12} In domestic animals, it involves the injection, through a catheter, of local anesthetic and antibiotics into a distended vein of a limb, distal to a tourniquet. In this manner, therapeutic antibiotic concentrations are reached in the tissues distal to the tourniquet using a relatively small dose of an-

tibiotic. The tourniquet is left in place for 30 min to achieve high therapeutic concentrations and to avoid noxious ischemia. Studies have shown that in cattle, when the tourniquet is removed, the drug is sequestered in the distal limb for almost 15 min, maintaining longer, high local concentrations of antibiotics. Complications following local i.v. anesthesia have occasionally been reported, but no complications have been reported to be associated with the injection of antibiotics.⁶

The technique has also been used successfully in horses with distal limb infections, with as few as two treatments producing resolution of severe cellulitis or pedal osteomyelitis (Anikis, pers. comm.). Given the potential for successful treatment of similar conditions in large, nondomestic mammals such as the elephant, regional digital i.v. perfusion was chosen to treat an Asian cow at the Paris Zoo that developed an acute sole abscess.

CASE REPORT

A 19-yr-old, approximately 3,000 kg female Asian elephant suddenly developed right forelimb lameness. She had a 2-yr-old baby and was too aggressive to examine closely. The elephants are housed in a 450-m² building with a brick floor and they have access to a 750 m² yard with dirt, concrete, and mud surfaces and a pool. The lame cow and calf were moved inside onto clean brick flooring. The right front foot was swollen, and there was no evidence of a nail problem or an external wound. There was a marked difference in temperature between the two feet (5.6°C) as measured with an infrared thermometer (Raynger MX2tm,

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Raytek Corporation, 1201 Shaffer Road, P.O. Box 1820, Santa Cruz, California 95061, USA). The cow was somewhat lethargic.

Initial differential diagnoses included digit fracture, soft tissue damage to the carpus, infection, and foreign body. Treatment was begun with phenylbutazone. (Equipalazone, Hoechst Roussel vet, 140 av Jean Lolive, 93695 Pantin cedex, France; 7 g, p.o., b.i.d.). The cow improved only slightly over the next 48 hr, and the phenylbutazone dose was increased to 9 g. The elephant's appetite and attitude improved, but after 6 days of anti-inflammatory therapy, the lameness and swelling persisted. Infection was considered likely. In addition, the cow had begun to explore the sole of her foot with her trunk repeatedly.

Anesthesia was elected for further diagnostic testing, and hoists were put in the stall. A thick layer of straw padding was placed on the ground. The cow was premedicated with xylazine (Rompun, Bayer Pharma, 13, rue Jean Jaurès, 92807 Puteaux cedex, France; 500 mg, i.m.) and ketamine (Imalgene 1000, Merial 17, rue Bourgelat, 69002 Lyon, France; 400 mg, i.m.) given via dart (Gut 50 rifle, Telinject, 57230 Sturzelsbronn, France). The elephant was only slightly sedated after 20 min, due in part to the presence of the calf. It was not possible to separate calf and cow despite several attempts. Anesthesia was induced with 1.4 ml of Large Animal Immobilon® (C-Vet Veterinary Products, Marathon Place, Moss Side Industrial Estate, Leyland, Lancashire, PR 5 3QN, United Kingdom; 2.45 mg/ml ethorphine hydrochloride, 10 mg/ml acepromazine maleate, i.m.), by dart 20 min after premedication. The calf was easily separated from the female when the latter became ataxic.

Induction was smooth, requiring 15 min. The cow went down into left lateral recumbency; thus, repositioning was not necessary. Venous access was obtained via a 21-gauge catheter (Vasocan, B. Braun, Melsungen AG, D-34209, Germany) in the right ear vein, and a slow perfusion of 0.9% NaCl (Macoflex, Maco Pharma, 96 rue du pont rompu, BP 464, 59338 Tourcoing cedex, France) was administered. Oxygen was delivered by nasal insufflation 15 L/min. Heart rate and relative oxyhemoglobin saturation was monitored via pulse oximetry (Vet/ox 4401, SDI 407 Pilot Court 400A, Waukesha, Wisconsin 53188, USA), with the probe placed on the tongue or vulva. The cow remained stable throughout the 78 min procedure, with heart rates of 36–41 bpm and oxyhemoglobin concentrations of 95–98%. Initial and final body temperatures were 37.9°C and 36.5°C, respectively.

A 10- × 0.5- × 0.5-cm piece of curved wire was



Figure 1. A 10- × 0.5- × 0.5-cm piece of curved wire was found penetrating the right front foot of a female Asian elephant.

found penetrating deeply into the sole (Fig. 1). On its removal, a purulent malodorous exudate drained from an abscess. The abscess pocket was 7 cm in diameter and 2 cm deep, although the wire had created a 10-cm-deep tract. The abscess was debrided, and the tract was flushed with hydrogen peroxide and dihydroxy-dimethyl-diphenylmethan-disulfonic polymerized acid 1% (Lotagen solution, Schering-Plough, 92, rue baudin, 92300 Levallois Perret, France).

Anteroposterior and lateral radiographs were obtained with a Gierth HF 300 portable machine (settings used were 80 kV, 15 mA, 0.3 sec, and 80 cm; Gierth GmbH, Löwengasse 13, 63263 Neu-Isenburg, Germany). There was no evidence of osteomyelitis, whereas there was an apparent old fracture of the third phalanx of the third digit, which was fragmented into two pieces. There was a high risk of osteomyelitis developing at this site or of the abscess extending to deeper structures because the wire had penetrated at least 10 cm; the elephant would require anesthesia for future treatments, and elephants with foot problems at the Paris Zoo have responded poorly to traditional therapy. Regional digital i.v. perfusion was thus performed.

A rope tourniquet was placed proximal to the



Figure 2. A rope tourniquet was placed above the right carpus, and venous access was obtained using a 21-gauge, 0.8 mm butterfly catheter in a palmar superficial vein of the right foot to perform regional interdigital perfusion.

right carpus. Venous access was obtained using a 21-gauge, 0.8-mm butterfly catheter (Microflex, Vygon, BP, 95440 Ecoeuven-France) in a palmar superficial vein of the right foot (Fig. 2).

A perfusate was prepared by adding heparin (Heparine Choay, Sanofi-Synthelabo, 174 Avenue de France, 75013 Paris, France; 1 ml) to 0.9% NaCl (5 ml) and combining this with 2% lidocaine (Xylovet, Sanofi, ZI de la ballastière-BP.126, 33501 Libourne cedex, France; 5 ml). This solution was combined with cefoxitin (Mefoxin, Merck, Sharp & Dohme-Chibret, 3 av Hoche, 75114 Paris cedex 08, France; 2 g, reconstituted to 20 mL using 0.9% NaCl) and gentamicin (Gentalline, Schering Plough, 92 rue baudin, 92307 Levallois-Perret, France; 2 g, diluted with 0.9% NaCl to 50 ml).

To avoid excessive bleeding, hemostatic and bactericidal gauzes (Surgicel, Johnson and Johnson, c/o European Logistics Center, 66 rue de la fusée, B-1130 Brussels, Belgium) were packed into the fistula, and a protective and compressive bandage was placed on the foot with gauze, elastic bandage (Velpau ZA de Choisy, 88200 Remiremont, France) and an adhesive bandage (Elastoplaste, Smith Nephew SA, 72019 Le Mans cedex 2, France). Routine complete blood count and a full biochemical profile were normal except for mild anemia.

Seventy-five minutes after original premedication, atipamezole (Antisedan N.D. Pfizer, 86 rue de Paris, 91407 Orsay cedex, France; 50 mg, i.v.) was given followed by diprenorphine hydrochloride (Large Animal Revivon, C- Vet Veterinary Prod-

ucts, Marathon Place, Moss Side Industrial Estate, Leyland, Lancashire, PR5 3QN, United Kingdom; 9.78 mg, divided half i.v. and half i.m.) The cow stood up 3 min later and ate normally later that day.

The bandage was removed 24 hr postoperatively for the elephant. Subsequent treatment included twice daily foot soaks in a 2- × 2- × 0.2-m concrete pool using a Dakin solution of monosodium carbonate (15 g) and active chlorine (Entreprise D. Richet, 02250 TAVAUUX; 5 g), and potassium permanganate (Sigma-Aldrich Chimie, Lisle d'Abeau, Chesnes, BP 701, 38297 Saint Quentin Fallavier cedex, France; 0.01 g) in 1 L of water. The cow continued to receive phenylbutazone (5 g, b.i.d., p.o.) for 1 wk and sulfamethoxazole-trimethoprim (Bactrim Forte, Roche, 52, Boulevard du parc, 92521, Neuilly sur Seine, France; 48 g, b.i.d., p.o.) for 4 wk. The elephant improved dramatically within 2 days, and the lameness and swelling had completely resolved within 9 days. To ensure complete recovery, the i.v. perfusion was repeated 15 days later with the same procedure. Radiographic appearance was unchanged. The abscess had resolved almost completely, and the draining tract was no longer present.

DISCUSSION

Sole or nail infections are common in captive Asian elephants and African elephants, with up to 50% of all captive elephants affected by foot-related problems.¹⁰ Similar conditions have occurred in wild elephants.⁹ Significant and debilitating complications, including pedal osteomyelitis, can develop from small or large abscesses.^{5,7} Infections involving the digital cushion are particularly difficult to treat because the tissue is relatively avascular.³ Successful treatment of foot problems in the elephant requires aggressive therapy. Daily debridement, lavage or foot soaks, administration of topical preparations including antibiotics, and parenteral antibiotic therapy have been recommended,⁸ and, in some cases, invasive surgery followed by long, intensive postoperative care has been necessary.³⁻⁵ Postoperative complications have been serious including ascending infection or secondary problems with the contralateral limb due to excess weight bearing.

Regional digital i.v. perfusion technique in the elephant was first used in an African cow with chronic osteomyelitis.¹³ The African elephant had multiple health problems, and the perfusion treatment was initiated after a sole abscess suddenly progressed to severe cellulitis and osteomyelitis involving all three phalanges of the third digit, including the distal third of the first phalanx. The cow

was managed in a free-contact setting and perfused daily, then weekly, without sedation or anesthesia for 7 mo. A pneumatic tourniquet designed for elephant foot surgery was used successfully (Pneumatic tourniquet, CDA products, Potter Valley, California 95469, USA).¹³ The technique was extrapolated from the regional digital i.v. perfusion method used in domestic horses, cattle, and rabbits.^{1,2,6,11,12}

Although a specialized pneumatic tourniquet was not available for the Asian cow in this study, the successful outcome suggests that the rope tourniquet was satisfactory. Venous access was more difficult in this Asian elephant, compared with the African elephant in which the procedure was first described.¹³ In the African elephant, the dorsal digital veins were readily visible, whereas in the Asian cow they were not obvious. Instead, the veins along the palmar aspect of the foot were easily identified. This difference may reflect anatomical differences between the species and also the fact that the African elephant was treated standing, with its foot raised on a pedestal, whereas the Asian elephant was recumbent and anesthetized. Anesthesia and lateral recumbency may have somewhat reduced venous return and improved the efficacy of the hand-held tourniquet.

It was not possible to determine antibiotic levels in the area of infusion in either elephant, although this data would be extremely helpful. The same antibiotics were used with both elephants to provide a broad spectrum of activity, particularly against anaerobes.

The Asian cow improved dramatically after a single treatment under anesthesia and offers compelling evidence that the regional perfusion technique is highly effective. The second treatment may not have been necessary. Given the relative simplicity of this therapy, regional digital i.v. perfusion should be considered as a treatment for sole abscessation in elephants. The procedure can be performed either with or without sedation or anesthesia, depending upon the management setting.

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LITERATURE CITED

1. Finsterbush, A., M. Argaman, and T. Sacks. 1970. Bone and joint perfusion with antibiotics in the treatment of experimental Staphylococcal infection in rabbits. *J. Bone Joint Surg.* 52-A: 1424–1432.
2. Finsterbush, A., and H. Weinberg. 1972. Venous perfusion of the limb with antibiotics for osteomyelitis and other chronic infections. *J. Bone Joint Surg.* 54-A: 1227–1234.
3. Fowler, M. E. 1993. Foot care in elephants. *In:* Fowler, M. E. (ed.). *Zoo and Wild Animal Medicine*, 3rd ed. W. B. Saunders Co., Philadelphia, Pennsylvania. Pp. 425, 448–454.
4. Fowler, M. E., E. P. Steffay, L. G. Galuppo, and J. R. Pascoe. 1999. Standing immobilization and anesthesia in an Asian elephant (*Elephas maximus*). *Proc. Am. Assoc. Zoo Vet.* 1999. P. 107.
5. Gage, L. J., M. E. Fowler, J. R. Pascoe, and D. Blasko. 1997. Surgical removal of infected phalanges from an Asian elephant (*Elaphus maximus*). *J. Zoo Anim. Med.* 28: 208–211.
6. Gangnon, H., J. G. Ferguson, M. G. Papich, and J. V. Bailey. 1994. Single-dose pharmacokinetics of cefazolin in bovine synovial fluid after intravenous regional injection. *J. Vet. Pharmacol. Ther.* 17: 31–37.
7. Hittmair, K. M., and H. D. Vielgrader. 2000. Radiographic diagnosis of lameness in African elephant (*Loxodonta africana*). *Vet. Radiol. Ultrasound* 41: 511–515.
8. Honeyman, V. L., R. M. Cooper, and S. R. Black. 1998. A protected contact approach to anesthesia and medical management of an Asian elephant (*Elaphus maximus*). *Proc. Am. Assoc. Zoo Vet./Am. Assoc. Wildl. Vet.* Pp. 338–341.
9. Keet, D. F., D. G. Groler, J. P. Raath, J. Gouws, J. Carstens, J. W. Nesbit. 1997. Ulcerative pododermatitis in a free ranging african elephant (*Loxodonta africana*) in the Kruger National Park. Onderstepoort. *Vet. Res.* 64: 25–32.
10. Mikota S. K., E. L. Sargent, and G. S. Ranglack. 1994. *Medical Management of the Elephant*. Indira, West Bloomfield, Michigan.
11. Murphey, E. D., E. M. Santschi, and M. G. Papich. 1999. Regional intravenous perfusion of the distal limb of horses with amikacin sulfate. *J. Vet. Pharmacol. Ther.* 22: 68–71.
12. Navarre, C. B., L. Zhang, S. Sunkara, S. H. Duran, and U. B. Kompella. 1999. Ceftiofur distribution in plasma and joint following regional limb injection in cattle. *J. Vet. Pharmacol. Ther.* 22: 13–19.
13. Spelman, L. H., R. Yates, P. Anikis, and L. Galuppo. 2000. Regional digital intravenous perfusion in an African elephant (*Loxodonta africana*). *Proc. Am. Assoc. Zoo. Vet.* 2000. Pp. 388–390.

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