Clinical Medicine

Wound Site as a Predictor of Complications Following Deep Nail Punctures to the Foot

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The site of injury, condition of the nail, and type of foot covering were compared in 36 inpatients and 34 outpatients with nail puncture wounds to the foot. Of the 36 inpatients, 34 (94%) had pyarthrosis, osteomyelitis, or both. The plantar surface of the foot was divided into 3 zones. Of the 36 inpatients, 35 (97%) had deep puncture wounds in zone 1. In contrast, only 6 of 34 (18%) outpatients had injury to this area. Tennis shoes were shown to predispose to infection with Pseudomonas aeruginosa. *Based on our findings, an early hospital admission should be considered for all patients with deep puncture wounds located in zone 1 and for patients who give a history of bone penetration in zone 2 or 3 at the time of injury. All patients who meet the above criteria and who are not admitted to hospital should be observed closely.*

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Nail puncture wound to the foot is a common injury that occurs at all ages. Numerous reports have been published that deal with the cause, diagnosis, management, and morbidity of infections following nail puncture wounds of the foot.[1-21] These reports have analyzed primarily patients who have required admission to hospital. Fitzgerald and Cowan reported on 869 patients with nail puncture wounds.[6] Of the 774 patients who were seen within 24 hours, 65 (8.4%) returned within four days with infection. Osteomyelitis developed in 14 (1.6%). Houston and co-workers evaluated 2,583 deep puncture wounds that included 280 (10.8%) cases with established infection when first seen. Of 2,303 "fresh" cases, infection subsequently developed in 51 (2.2%).

There are no reports to our knowledge that give criteria for hospital admission in the absence of disease following deep nail puncture wounds of the foot. We compare the sites of puncture, condition of the nail, and the foot covering in 36 inpatients with those of 34 outpatients who did not require hospital admission but who were evaluated after the injury at the Los Angeles County-University of Southern California (LAC/USC) Medical Center.

Patients and Methods

Inpatients

From July 1980 through September 1987, 36 patients were admitted to the Orthopaedic Infection Service or the Pediatric Pavilion at the LAC/USC Medical Center for infection following nail puncture wounds of the foot; 32 were male. Ages ranged from 4 to 59 years (median, 22), with 15 patients younger than 15 years and 21 adults older than 18. Three fourths of the patients (27) had medical attention before admission. Of these, 25 received an oral antibiotic either alone or after a single intramuscular injection of a cephalosporin. The time from injury to hospital admission ranged from 1 to 30 days (median, 9 days); 15 patients (42%) were admitted 14 or more days after the injury.

Outpatients

By reviewing outpatient medical records of daily visits, we identified 34 patients during 1986 and 1987 who did not require hospital admission following nail puncture wound to the foot; 29 were male. Ages ranged from 2 to 62 years (median, 28 years), with 9 patients younger than and 25 older than 18 years of age. Nearly 62% (21) of the patients were seen on the day of injury. Only three patients did not seek medical attention within 72 hours following the injury. We saw no seasonal pattern to the occurrence of this type of injury.

Results

Of the 36 inpatients, 2 had soft tissue infection involving a web space of the foot. The diagnosis and site of infection for the 34 inpatients with bone or joint involvement (or both) are given in Table 1. Combined pyarthrosis and osteomyelitis occurred in 19 patients, 11 had pyarthrosis, and 4 had osteomyelitis.

We divided the foot into three zones to determine if the site of puncture wound influenced the need for subsequent hospital care (Figure 1). Zone 1 encompasses the area that overlies the metatarsal neck region and extends distally to the end of the toes. Zone 2 extends from the distal end of the calcaneus to the neck of the metatarsals and overlies all of the tarsal bones and joints and the shaft of the metatarsals. Zone 3 overlies the calcaneus. We compared the zone location for nail wounds in the 36 inpatients and 34 outpatients. In 35

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inpatients, the nail puncture site was located in zone 1, with one found in zone 3 and none in zone 2. This can be contrasted to the location of the puncture site in the 34 outpatients, wherein 6 were located in zone 1, 23 in zone 2, 4 in zone 3, and 1 was not described. Tenting of the skin in the web space as described in one patient assigned to zone 1 pointed to involvement of the soft tissue only.

The type of foot covering and the condition of the penetrating nail are given in Tables 2 and 3, respectively. Of the 18 patients from both groups known to be wearing tennis shoes at the time of injury, 14 (78%) required admission to hospital. Of the inpatients in whom foot covering was known, 14/17 (82%) were wearing tennis shoes at the time of injury. The condition of the nail did not influence the need for hospital stay. It is of interest that *Pseudomonas aeruginosa* was grown from cultures of specimens from 13 of the 14 inpatients who were wearing tennis shoes; 1 had no growth.

Discussion

The incidence of serious complications has been reported to be 3% to 10% following a nail puncture wound to the foot.[1,6] This points to a need to identify those patients at risk for complications so that earlier definitive treatment can be given to decrease morbidity. We divided the plantar surface of the foot into three zones and looked for a difference in the site of injury to persons who were or were not admitted to hospital. Our data showed that puncture wounds in zone 1 were at the highest risk for the subsequent development of osteomyelitis, pyarthrosis, or both, followed by those of zone 3.

The data of previous investigators offer support to our observation that nail puncture wounds in zone 1 are at the highest risk for complications, followed by zone 3. Of 81 reported cases of osteomyelitis or pyarthrosis following a nail puncture wound to the plantar area of the foot, we were able to place 58 wounds into our zone classification.[2-5,7,9-12,14,16,19-21] Of the 58 wounds, 29 (50%) were in zone 1, 10 (17%) were in zone 2, and 19 (33%) in zone 3. Of the 23 cases not adequately described, 13 were reported to involve a metatarsus. The greatest risk for joint or bone penetration by a nail puncture in zone 1 can be attributed to the small amount of overlying soft tissue and by the fact that the metatarsal heads are a primary weight-bearing area of the foot. Conversely, the metatarsal arch and abundant soft tissue pad offer protection against bone or joint penetration from puncture wounds in zone 2. Its occurrence in zone 2 would more likely result from a puncture to the lateral rather than the medial aspect of the foot. Although the calcaneus is covered by the greatest amount of soft tissue, it is at risk for penetration by being a major weight-bearing area of the foot. Of 34 of our inpatient population, however, only 1 (2.9%) compared with 19/58 (33%) of previously reported cases had calcaneal osteomyelitis. The uncommon occurrence of calcaneal osteomyelitis following nail puncture wound may have influenced the reporting of cases.[3,13]

P aeruginosa is recognized as the most common infecting

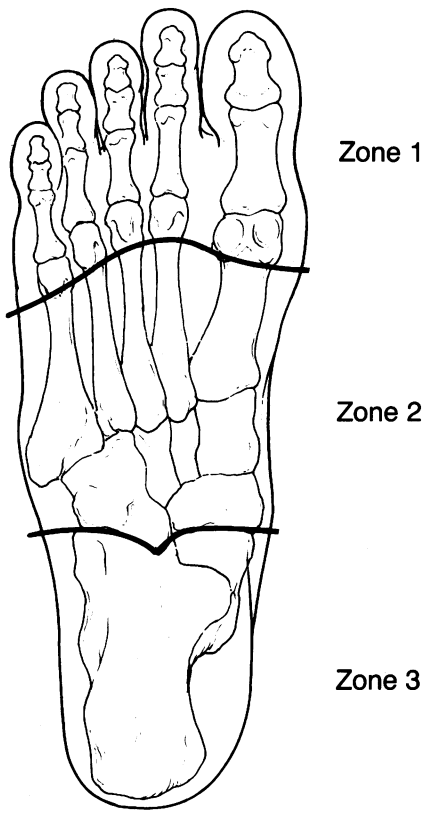

Figure 1.—The drawing shows the zones of the plantar surface of the foot.

TABLE 1.—*Type and Location of Infection in 34* Inpatients With Bone, or Joint Involvement or Both*

Location	Type of Infection: Pyarthrosis, No.	Osteomyelitis, No.	Combined, No.
MTP Joints			
1st	8	1	5
2nd	1	0	6
3rd	1	1	3
4th	1	0	4
5th	0	0	1
PIP Joint			
1st	0	1	0
Calcaneus	0	1	0

MTP=metatarsophalangeal, PIP=proximal interphalangeal

*Excluded 2 soft tissue infections.

TABLE 2.—*Type of Foot Covering*

Foot Covering	Inpatient, No.	Outpatient, No.
Tennis shoe	14	4
Shoe	2	8
Barefoot	1	2
Not known	19	20
Total	36	34

TABLE 3.—*Condition of Nail*

Nail Condition	Inpatient, No.	Outpatient, No.
Clean	5	8
Rusty	12	14
Dirty	1	2
Unknown	1	0
Not described	17	10
Total	36	34

organism following nail puncture wound to the foot.* Our findings further support that the wearing of tennis shoes at the time of nail puncture to the foot predisposes to infection with *P aeruginosa* in all age groups. We, unlike Minnefor and colleagues,[4] found no seasonal peak incidence of *P aeruginosa* osteomyelitis.

Conclusion

Based on our findings, hospital admission at the time of the initial medical evaluation of early deep puncture wounds of the foot, in the absence of clinical infection, should be considered for patients with wounds located in zone 1 and for patients who give a history of bone puncture in zone 2 or 3 at the time of injury. All patients who meet the above criteria and who are not admitted to hospital should be observed closely. Antibiotics chosen for patients wearing tennis shoes at the time of injury should have activity against *P aeruginosa.*

*References 2, 4, 5, 7, 10, 11, 13, 14-18, 21.

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