**Introduction**

Antibiotic cement spacers have been used in various aspects of orthopedic fields including bone infection and open fracture [1-3]. Surgical excision and debridement of non-viable and infected soft tissue and bone followed by antibiotic cement spacer placement were performed to alleviate bone infection [2,4].

There are some literatures concerning the treatment using antibiotic cement spacer in foot and ankle infection [1-6]. But there are only few literatures with respect to the appropriate time of removing the cement spacer and complications that occur without its removal.

The purpose of this study is to analyze the results of treatment of foot and ankle infection with an antibiotic cement spacer.

**Materials and Methods**

Twenty-seven patients who underwent surgical treatment for bone infections of the foot and ankle using an antibiotic cement spacer during the period from July 2014 to June 2019, and were followed up for more than one year were selected as subjects for the present retrospective analysis. The subject was divided into Group A (19 subjects), in which the antibiotic cement spacer was removed during treatment, and Group B (8 subjects), with non-removal of antibiotic cement spacers during treatment, for analysis in the present study. The erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), white blood cell count between the time of the initial infection diagnosis and 6-weeks after surgery were analyzed, together with complications occurring within one year after completion of the surgical treatment.

**Results:** The subjects in both groups exhibited reductions in ESR, CRP, and WBC count 6 weeks after the surgical treatment compared to the results before surgery. No cases of additional amputations due to failure of infection control were commonly observed in Groups A and B, however five episodes of complications were observed in Group A and two episodes of complications were observed in Group B, respectively. However, significant differences were not found between the two groups.

**Conclusions:** The use of antibiotic cement spacers in surgery for the treatment of bone infection in the foot and ankle rendered satisfactory outcomes. Further, it was also found that satisfactory outcomes could be obtained without removal of the antibiotic cement spacer over a short-term follow-up.

**Keywords**

Infection, Foot and ankle, Antibiotic cement spacer
Complications occurring within one year after completion of the surgical treatment.

P-values were calculated using Pearson’s chi-square test, Fisher’s exact test and Mann-Whitney U test. P-value less than 0.05 was considered to indicate statistical significance.

Results

There were 14 cases of infection of the toes or metatarsophalangeal joint, 2 cases of the infection of the mid-foot, 5 cases of infection of the calcaneus and 6 cases of infection of the ankle joint. The average time of removal of the cement spacer was 43.6 days. The subjects in both groups exhibited reductions in ESR, CRP, and WBC count 6 weeks after the surgical treatment compared to the results before surgery, but there were no significant differences between the two groups. No cases of additional amputations due to failure of infection control were commonly observed in Groups A and B; however, five episodes of complications were observed in Group A and two episodes of complications were observed in Group B, respectively. However, significant differences were not found between the two groups (Table 1).

Discussions

Since Haboush, [7] introduced the application of bone cement in total hip arthroplasty to achieve stability of the femoral stem, bone cement has been used in total hip arthroplasty only. Buchholz and Engelbrecht, [8] reported the surgical outcomes of the treatment of deep infection after total hip arthroplasty using antibiotic bone cement, and afterwards, it has been used widely in open fracture, infected arthroplasty, non-union, and acute or chronic osteomyelitis [4]. With respect to the foot and ankle infection, an antibiotic cement spacer plays an important role of alleviating infections by prevention soft tissue contracture or bone shortening and avoiding amputation [1,2,4,5].

The antibiotic chosen for bone cement should have a broad spectrum of microbicidal activity and it should not cause any serious allergic reaction in the human body [3,4]. Gentamycin and Vancomycin have been used in bone cement as they have all of these characteristics [2,9,10]. Although the mechanism of antibiotic release is still debated, it is hypothesized that elution of the antibiotic from bone cement occurs rapidly and in large amounts during the first days and it progressively decreases until about 2 to 14 days, with the remaining antibiotic persisting with a clinically insignificant release over several years [3-6,1,1].

Antibiotic bone cement can have a direct effect on the infected area where the biofilm is already formed because it has a relatively high dose of antibiotics, compared to systemic antibiotics [8,9]. Thus, it can be an alternative treatment even in patients with peripheral vascular disease and those with serious side effects of systemic antibiotics [6]. But the use of intravenous antibiotics should not be stopped because residual infection may remain or suboptimal antibiotic sensitivity may exist [5]. In this study, systemic antibiotics were additionally used in all cases but the duration of the antibiotic administration was 2 weeks less than 6 weeks on average in bone infection [1,2]. The authors believed that the use of antibiotic cement spacer in combination with systemic antibiotics may shorten the treatment period for foot and ankle bone infection.

Table 1: Association of variables between group A (removal of antibiotic bone cement spacer) and group B (not removal).

|                         | Group A (n = 19) | Group B (n = 8) | P-value |
|-------------------------|-----------------|----------------|---------|
| Male                    | 6               | 3              | > 0.999 |
| Female                  | 13              | 5              |         |
| Age                     | 60.79 ± 9.20    | 66.25 ± 7.36   | 0.089   |
| DM                      | 11 (57.9%)      | 1 (12.5%)      | 0.043   |
| Location                |                 |                | 0.105   |
| Metatarsophalangeal joint| 8               | 1              |         |
| Ankle                   | 3               | 3              |         |
| Calcaneus               | 4               | 1              |         |
| Midfoot                 | 0               | 2              |         |
| Toe                     | 4               | 1              |         |
| ESR(mm/h)               |                 |                |         |
| Pre-op                  | 45.95 ± 32.98   | 37.25 ± 26.41  | 0.595   |
| Follow up               | 19.58 ± 19.63   | 28.00 ± 18.29  | 0.159   |
| CRP(mm/h)               |                 |                |         |
| Pre-op                  | 27.12 ± 50.95   | 36.69 ± 83.40  | 0.541   |
| Follow up               | 7.51 ± 18.34    | 6.16 ± 11.95   | 0.441   |
| WBC count (x10^3 cells/μl) |         |                |         |
| Pre-op                  | 8.10 ± 2.52     | 7.78 ± 3.19    | 0.595   |
| Follow up               | 6.38 ± 1.46     | 6.18 ± 1.65    | 0.937   |
| Duration of administration of antibiotic (weeks) | 4.79 ± 2.37 | 4.13 ± 2.03 | 0.517 |
| Complications           | 5(26.3%)        | 2 (25.0%)      | > 0.999 |
Melamed EA, et al. [2] reported that the antibiotic cement spacer was not removed in 10 of 23 cases and there were no serious complications, such as recurrence of infection except for callosity of the foot. Elmarsafi T, et al. [5] reported that there were no complications during an average follow-up of 52 months without removal of the antibiotic cement spacer. Although there might be an adverse effect, the antibiotic spacer could serve as a site for bacterial colonization long after release of the antibiotic [2,6]. There was no case of incomplete wound healing or recurrence of infection for 1 year in our patients.

A callosity was formed on the plantar side of the forefoot in 2 cases in which the antibiotic cement spacer was not removed at the first metatarsophalangeal (MP) joint. We believed that pressure might have been transmitted to the lesser toes and a callosity could have formed because the cement spacer could not resist the weight bearing on the first MP joint [12-14]. The antibiotic cement spacer may provide structural stability and allow motion but careful attention should be paid when the cement spacer is inserted in a weight bearing position, such as a metatarsal head.

This report is limited as our study was retrospective in nature and it had a small sample size.

Conclusions

The use of antibiotic cement spacers in surgery for the treatment of bone infection in the foot and ankle achieved satisfactory outcomes. Further, it was also found that satisfactory outcomes could be obtained without removal of the antibiotic cement spacer over a short-term follow-up.

Authors Declaration

The authors declare that authors have no conflict of interest.

References

1. Park SJ, Song SC (2019) Risk factors for the treatment failure of antibiotic-loaded cement spacer insertion in diabetic foot infection. J Korean Foot ankle Soc 23: 57-66.
2. Melamed EA, Peled E (2012) Antibiotic impregnated cement spacer for salvage of diabetic osteomyelitis. Foot Ankle Int 33: 213-219.
3. Wininger DA, Fass RJ (1996) Antibiotic-impregnated cement beads for orthopedic infections. Antimicrob Agents Chemother 40: 2675-2679.
4. Schade VL, Roukis TS (2010) The role of polymethylmethacrylate antibiotic-loaded cement in addition to debridement for the treatment of soft tissue and osseous infections of the foot and ankle. J Foot Ankle Surg 49: 55-62.
5. Elmarsafi T, Oliver NG, Steinberg JS, Evans KK, Attinger CE, et al. (2017) Long-term outcomes of permanent cement spacers in the infected foot. J Foot Ankle Surg 56: 287-290.
6. Schwarz EM, McLaren AC, Sculco TP, Brause B, Bostrom M, et al. (2020) Adjuvant antibiotic-loaded bone cement: Concerns with current use and research to make it work. J Orthop Res 30: 10.
7. Haboush EJ (1953) A new operation for arthroplasty of the hip based on biomechanics, photoelasticity, fast-setting dental acrylic, and other considerations. Bull Hosp Joint Dis 14: 242-277.
8. Buchholz HW, Engelbrecht H (1970) Depot effects of various antibiotics mixed with Palacos resins. Chirurg 41: 511-515.
9. Hanssen AD (2005) Local antibiotic delivery vehicles in the treatment of musculoskeletal infection. Clin Orthop Relat Res 437: 91-96.
10. Roeder B, Van Gils CC, Maling S (2000) Antibiotic beads in the treatment of diabetic pedicle osteomyelitis. J Foot Ankle Surg 39: 124-130.
11. Krause FG, DeVries G, Meakin C, Kalla TP, Younger AS (2009) Outcome of transmetatarsal amputations in diabetics using antibiotic beads. Foot Ankle Int 30: 486-493.
12. Raymakers R, Waugh W (1971) The treatment of metatarsalgia with hallux valgus. J Bone Joint Surg 53-B: 684-687.
13. DeSandis B, Pino A, Levine DS, Roberts M, Deland J, et al. (2016) Functional outcomes following first metatarsophalangeal arthrodesis. Foot Ankle Int 37: 715-721.
14. Brodsky JW, Baum BS, Pollo FE, Mehta H (2007) Prospective gait analysis in patients with first metatarsophalangeal joint arthrodesis for hallux rigidus. Foot Ankle Int 28: 162-165.