

TABLE 1. List of publications

Author	Year	Journal	Study Period	Country	Population Size
Faroug [1]	2009	Hip International	2004-2009	United Kingdom	2
Anagnostakos [2]	2010	Hip International	1999-2008	Germany	12
Lee [3]	2013	Acta Orthopaedica	2005-2010	South Korea	19
Ekpo[4]	2013	Clin Orthop.	2000-2011	USA	19
Lombardi [5]	2014	Bone and Joint	2011-	USA	7
Fukui [6]	2015	Journal of Orthopaedics	2009-2014	Japan	5
El-Husseiny [7]	2016	Clin Orthop.	2000-2010	United Kingdom	18
Ji [8]	2016	International Orthopaedics	2000-2013	China	31
Chen [9]	2017	International Orthopaedics	2004-2013	China	16

and 17 femur-only revisions. There were 11 failures in the acetabulum-only group (9.7%) and 2 failures in the femur-only group (11.7%). There was no statistically significant difference between the groups. The offending bacteria in the studies are similar to what is expected to be seen in PJs.

In conclusion, given that in THA and TKA the surfaces of prosthetic material are in contact with bone and knowing the fact that infective organisms are capable of attaching to foreign material surfaces and forming biofilms, we are inclined to believe that partial infection of a prosthesis does not exist. Infective organisms are capable of accessing the effective joint space in the hip and the knee and infecting the entire prosthesis. However, there may be rare circumstances when an implant is well-fixed, either by cement or through osseointegration, and the infective agents are not able to access the prosthesis-bone interface. There were no studies to prove or disprove this assumption. If such a situation existed, then a resolute approach for radical resection of all implants could plausibly lead to an overtreatment and unnecessary morbidity.

Based on the scant data available, it appears that partial retention of well-fixed implants in patients with reconstructive challenges may be a viable option. Such surgical options should only be reserved for patients in whom removal of well-fixed implants are likely to compromise or prevent a later reconstruction. The basic principles of aggressive soft-tissue debridement and complete removal of infected implants should still be obeyed for the majority of patients.

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QUESTION 6: Should heterotopic ossification (HO) be removed during resection arthroplasty of an infected prosthetic joint?

RECOMMENDATION: We recommend that surgeons give strong consideration to removal of accessible HO in an infected prosthetic joint that will not compromise future reconstruction.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 80%, Disagree: 10%, Abstain: 10% (Super Majority, Strong Consensus)

RATIONALE

HO is the presence of bone in soft tissue where bone does not exist. Several risk factors have been associated with HO such as spinal cord injury, head injury, neurologic disorders, osteoarthritis, male gender, burns, other trauma with severe soft tissue damage and joint arthroplasty. The presence of HO at an infected prosthetic joint may be encountered during the time of resection arthroplasty. HO should be removed if present within the infected area, if it interferes with adequate exposure and debridement or when it could potentially interfere with function after resection arthroplasty. Following surgical resection of the heterotopic bone, beneficial effects on the range of motion and pain relief have been described. However, there are still controversies about the optimal timing for surgical resection.

A perioperative regimen is crucial for recurrent prophylaxis. Non-steroidal anti-inflammatory medications (NSAIDs) and radio-

therapy have demonstrated beneficial effects on HO prophylaxis with low recurrence rates for a number of indications such as total hip arthroplasty and acetabular surgery. Resection arthroplasty is an effective modality to treat hip arthroplasty infections with HO. If subsequently the patient develops HO while he or she is mobilized, it may facilitate walking on that hip [1].

However, in an extensive search of the English literature we were unable to find any relevant studies that investigate the effect of resection of HO at the time of resection arthroplasty on surgical outcomes.

REFERENCE

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QUESTION 7: When soft tissue coverage requires a reconstructive flap, can it be performed at the time of explant or should it be deferred until reimplantation?

RECOMMENDATION: When a soft tissue defect requires a reconstructive flap, it is safe to perform flap coverage at the time of explant or at the time of reimplantation. Early flap coverage at the time of explantation improves soft tissue biology for eradication of infection and allows for earlier mobilization following reimplantation given greater flap maturity.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 95%, Disagree: 2%, Abstain: 3% (Unanimous, Strongest Consensus)

RATIONALE

No prospective comparative studies were identified which compared patient groups who have had soft tissue reconstruction flaps performed at the time of explant versus at the time of reimplantation. Much of the literature pertinent to this question comprises heterogeneous series of patients who have exposed or infected total knee arthroplasty (TKA) implants. For TKA soft tissue defects, medial gastrocnemius rotational flaps were most commonly reported. However, many additional rotational and free flaps have been described: lateral gastrocnemius, latissimus dorsi, local fascio-cutaneous, quadriceps advancement, sartorius and rectus abdominus.

Tetreault et al. [1] published the only study identified which evaluated patients based on the timing of flap coverage. Treatment was based on surgeon opinion of insufficient soft tissues. The cohort was heterogeneous, including patients who received medial gastrocnemius flaps at the time of explantation, repeat spacer, reimplantation or irrigation and debridement with liner exchange. There was a non-significant trend toward higher failure rates when the flap was performed with spacer implantation (first or repeat) compared to definitive implants (reimplantation or retention with liner exchange). The overall reinfection rate among all groups was 52% at 4 years. Selection bias likely impacted these results and the authors clearly state that flap timing was based on necessity, rather than a belief that the timing was advantageous. Corten et al. [2] and Young et al. [3] described standardized staged protocols for the management of infected or exposed TKA implants, including soft tissue coverage at the time of explantation, with disparate results. While Corten reports 92% flap survival and one case of reinfection, patients in Young's series had a 29% amputation rate. Ries et al. [4] described

a mixed cohort, which included seven patients who underwent soft tissue coverage at the time of spacer insertion. Four patients were treated successfully, while one flap failed and two went on to experience recurrent infection. Gerwin et al. [5] and Browne et al. [6] used flaps between revision stages and at the time of repeat spacer, respectively. Both series reported relative success, with 83% and 78% successful reimplantations, respectively.

McPherson et al. [7] reported on the only identified cohort of staged revision with flap during reimplantation. They described 5% recurrent infections and 33% wound complications among 21 patients.

Based on these published reports, there is limited evidence to support soft tissue flap reconstruction at the time of implant removal and antibiotic cement spacer insertion. By contrast, a small body of literature appears to support deferral of soft tissue coverage until reimplantation of a revision implant. However, these patient populations are not necessarily comparable within the limited body of evidence available. Most studies report high rates of complications, including recurrent infection, recurrent soft tissue defects and subsequent limb loss, highlighting the difficulty of this clinical problem regardless of treatment approach. Based on this literature, as well as experience, we prefer the former approach, given the benefits of improved soft tissue coverage and biology to the eradication of infection. Furthermore, performance of flap coverage at the time of explantation allows for unrestricted rehabilitation following later reimplantation.

Of note, numerous older studies were identified which describe the usage of soft tissue flaps to facilitate implant retention; however,