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Mini Review on the Impact of Mobile Parts' Exchange During the DAIR Procedure (Debridement, Antibiotics, Irrigation, Retention) for Infected Total Joint Arthroplasties

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Abstract

A prosthetic joint infection (PJI) requires a combined approach (infectiology and surgery). The therapeutic DAIR approach (debridement, antibiotics, irrigation, and retention) is an option for acute and stable PJI yielding remission incidences that oscillate between 70% and 90%; in a literature mostly composed of retrospective single-center trials. DAIR can be performed with or without mobile part's exchange during debridement. Scientific data proving the necessity of mobile part exchanges (by leaving other infected components *in situ*) remain scarce. In this narrative mini review, we evaluate the existing literature that analyses the benefit of exchanging mobile parts with at least ten own cases. We moreover discuss the optimal duration of concomitant targeted systemic antibiotic therapy and reveal some insights in the surgical difficulties in performing DAIR. Our conclusion tends to favor of the mobile part's exchange whenever feasible.

Introduction

A prosthetic joint infection (PJI) is a serious complication of arthroplasty surgery occurring in 0.8 to 1.9% of knee arthroplasties and 0.3 to 1.7% of hip arthroplasties¹. PJIs require both antimicrobial treatment and surgical interventions. While the practice of the antibiotic therapy relies on uniform concepts throughout the world, the surgical approach resumes a higher variance and bases on the surgeon's experience or the co-morbidities of the patients. Possible strategies include a one- or two-stage implant exchange, resection arthroplasty (with or without arthrodesis), or DAIR^{1,2} (debridement, antibiotics, irrigation, and retention). Notably, DAIR can be used either curatively or as an initiation of a long-term suppressive antibiotic therapy³. The curative DAIR approach implies an acute infection with a stable implant and can reveal remissions up to 70%-90% in selected patient population^{4,5}. In this sense, the potential of DAIR lags behind the complete arthroplasty exchanges only by some percent^{6,7}.

Scientific data proving the necessity of mobile part exchanges (polyethylene, liners, heads, inlays; by leaving other infected components *in situ*) remain scarce, although many experts advocate it for theoretical reasons¹⁻⁹. In this narrative mini review, we evaluate existing literature regarding the benefit of exchanging mobile parts, discuss the optimal duration of concomitant targeted systemic

antibiotic therapy, and reveal some insights in the surgical difficulties in performing DAIR. In contrast, we do not review the microbiology, the choice of antibiotic agents, the detailed surgical techniques, DAIR as suppressive purposes, or the demographics of DAIR patients around the world, for which specific literature are available.

Methods

We conducted a literature review that was oriented on the PRISMA procedure and targeted the benefits of mobile parts' exchange in DAIR of hip and knee PJIs; including all available publications with patient recruitment until 31 May 2019; with the MESH terms "DAIR", "infection" together with "exchange", "mobile parts" or "inlay" in English, German or French languages in PubMed and Google (Scholar). We also searched the reference lists of retrieved articles for additional papers. We excluded reviews, opinion papers, publications in other languages, publications without specific data on the mobile part's exchange, DAIR as suppressive therapy indications, DAIR in mycobacterial or fungal PJIs, and repeat papers issuing from the (presumed) same database (same author groups). For this mini literature review without providing own patient data, there were no ethical concerns. The primary outcome was "remission" linked to the presence or documented absence of previous mobile part's exchange.

Results

We retrieved twenty well documented articles reporting (more than) ten own DAIR cases, and that equally display information about mobile parts' exchanges^{5,8-27}. All were retrospective analyses with a similar case-control design, but with different outcomes. In six studies, the exchange of the mobile parts was reported, but was not of important scientific interest, because we could not link exchange

with remission outcomes. Fourteen studies explicitly investigated the prognostic value of the mobile parts' exchange and are now resumed in Table 1. Among them, six studies (resuming 1035 patients) reporting a benefit of the mobile part's exchange, and eight (605 cases) denied such a benefit (Table 1).

Overall, remission rates in DAIR with mobile parts' exchange ranged up to 90%. Studies in favor of the exchange reported a two- or even four-fold increase in the benefit; probably independent of other co-factors. The described increase of the remission incidence of mobile parts' exchange ranged from 53%-92% (estimated interquartile range 65-85%) compared to maximally 77% remission in a DAIR procedure explicitly without mobile parts' exchange (estimated interquartile range 60-70%). In terms of infection remission, there seems to be no difference between the DAIR procedures in total hip or in total knee PJIs. The diversity of the articles, their contents, the detailed information displayed, and the patient population was too heterogonous to allow a statistically formal (pseudo)-meta-analysis.

Importantly, none of the studies reported an adverse event related to the mobile parts' exchange, but adverse events of the mobile part's exchange have never been the primary study objectives. One retrospective study looked for antibiotic-related adverse events in curative DAIR patients, and found no specific variations according the various substrata of the DAIR population¹⁸. Also, we lack information regarding other clinically important non-infectious outcomes (e.g. persistent pain or mechanical handicaps), surgical costs, and surgical difficulties when comparing between a DAIR for total hip or total knee PJIs¹⁻⁴². There is one exception: the functional outcomes of DAIR with a primary (uninfected) hip arthroplasty and a two-

Table 1: Mini-review on Infected Hip and/or Knee Total Joint Arthroplasties with the Emphasis on the Influence of Mobile-part's Changes During DAIR.

First Author	Cases	Mobile parts exchanged	Overall Remission	Reported benefit of mobile parts' exchange	Remission with mobile parts' exchange	Remission without mobile parts' exchange	Study design	Years
Deirmengian ²⁴	31	10 (32%)	35%	none	n/a	n/a	retrospective	1990-2000
Peel ¹¹	43	18 (42%)	86%	none	83% (of 18)	76% (of 25)	retrospective	2000-2010
Achermann ⁵	50	26 (52%)	92%	none	n/a	n/a	retrospective	2005-2010
Choi ²¹	28	19 (68%)	50%	none	n/a	n/a	retrospective	1999-2007
Koh ¹⁴	52	49 (94%)	71%	none	73% (of 49)	33% (of 3)	retrospective	2005-2012
Tornero ²⁶	222	159 (72%)	77%	none	77% (of 159)	76% (of 63)	retrospective	1999-2014
Bryen ³⁵	112	63 (56%)	83%	none	n/a	n/a	retrospective	2000-2012
Ottesen ¹²	67	18 (31%)	84%	none	78% (of 18)	90% (of 40)	retrospective	2008-2013
Lora-Tamayo ³⁰	418	220 (53%)	58%	2-fold benefit	65 % (of 211)	48 % (of 190)	retrospective	2003-2012
Hirsiger ¹⁸	112	48 (43%)	84%	2-fold benefit	83% (of 48)	84% (of 64)	retrospective	2004-2017
Choi ²⁰	32	19 (59%)	31%	3-fold benefit	53% (of 19)	0% (of 13)	retrospective	2002-2007
Wouthuyzen ⁸	323	176 (54%)	55%	3-fold benefit	63% (of 176)	48% (of 147)	retrospective	2005-2015
Grammatopoulos ¹⁹	122	65 (53%)	68%	4-fold benefit	92% (of 65)	77% (of 57)	retrospective	1997-2013
Kim ¹⁵	28	11 (39%)	61%	14-fold benefit	91% (of 11)	41% (of 17)	retrospective	2003-2012

stage arthroplasty exchange in hip PJI's were compared⁴³. The DAIR group had an overall inferior functional Oxford Hip Score at five year's follow-up compared to the two-stage exchange in hip PJI's (but similar remission of infection)⁴³ but the subpopulation that required only one DAIR debridement for eradication of infection had a mean score to the primary uninfected arthroplasty group.

Discussion

Motivated by our single-center analysis proving a benefit of the mobile part exchange in DAIR¹⁸, we add this mini-review targeting to the statistical benefits of this exchange; which was always highly advocated by experts¹⁻⁹, met its own review objectives, but was less underlined by solid scientific data. Indeed, so far the literature investigated showed other independent co-factors on the outcome of DAIR such as associations with pathogens³⁰⁻⁴¹ (especially *Staphylococcus aureus*), choice of particular antimicrobial agents³¹, multidrug-resistance, polymicrobial PJI (especially involving fungi), bacteremic disease, the height of serum inflammation markers, presence of immune-suppression, active smoking, and subacute PJI's lasting since more than one month^{2,26-41}.

Recent years acknowledged a statistical benefit in exchanging mobile parts, although this opinion is not shared by all research groups (Table 1). Hence, the statistical support for a widespread practice came later than the expert opinion¹⁻⁹. However, and importantly, our "statistical support" bases on retrospective data with all possible biases and confounding by indications. As no data from randomized trials exist, we cannot exclude the hypothesis that perhaps more severely ill patients or with more complicated surgical issues were not submitted to exchange of mobile components. To give an extended example, the Grammatopoulos paper concludes that even in late PJI, exchange of mobile parts is better than their preservation during DAIR. However, it is not clear if exchange was performed more often in early than late PJI, in younger than older patients, or in patients who were pre-operated for PJI^{19,43}. Other papers do not mention at all the reasons for this important choice regarding DAIR.

Furthermore, the exchange of mobile parts is always reported as a dichotomous parameter (exchange of mobile part conducted versus not conducted). Hence, details about the procedure (e.g. duration, methodical approach) are not taken into account. We also lack important clinical evaluations in the DAIR procedure (with and without exchange of mobile parts) such as functional outcomes, costs and quality of life assessments. The same is true for the surgical team and the course of the operation, which might play a role, however, cannot be measured by objective parameters and thus have not been included in any study. In order to preoperatively assess the risk of failure after DAIR, there have been efforts to develop scores like the

KLIC-Score for early acute PJI and the CRIME80-Score for acute hematogenous PJIs; both holding moderate evidence, but a strong international consensus^{2,8,26,29}. The KLIC-Score has already been validated externally²⁹.

Generally speaking, hematogenous total knee PJI's may occur later than their counterparts in the hip⁴¹, but we ignore if this is also true for the subpopulation of patients chosen for the curative DAIR approach. From an orthopedic surgeon's point of view, total knee arthroplasties in general may be associated with more post-surgical pain, reduced range of motion, and even stiffness than total hip arthroplasties^{9,14,19}. Surgeons would also expect that knee DAIRs would be associated with more discomfort even after infection eradication, but specific data are lacking to the best of our knowledge. Technically speaking, there are no major differences in difficulty performing DAIR for knee compared to hip PJIs, even regarding the exchange of mobile parts; with the only exception of tibial insert^{16,23,36}. Both articulations require the availability of individual exchange material, because every arthroplasty type and size has its own material produced by the manufacturer, which has to be replaced identically. To the best of our knowledge, we ignore if some author groups experienced DAIR with a replacement of mobile parts from another manufacturer. It seems not possible to insert a tibial inlay from different companies. In contrast, the change of the thickness of the tibial insert is possible; almost never into a smaller size, but frequently into a larger one to enhance the stability⁴⁴.

The number of surgical debridements for one DAIR episode does not seem to enhance remission, i.e. a second look does not seem being more beneficiary than a single debridement with direct mobile parts exchange⁴². In Switzerland, the country of this mini review, the changing of inlays roughly costs 1000 US\$, a new prosthesis around 6000 \$, and a revision arthroplasty 8000 \$ or more according to the personal experience of the orthopedic surgeons in the last decade.

Although not the objective of this mini review, the duration of concomitant antibiotic therapy after DAIR is a subject of debate. Briefly, many centers treat either during six weeks, and many during twelve weeks or longer; independently of the involved pathogens, patient's comorbidities, or the exchange of mobile parts. According to available literature, the infection remission does not seem to differ between all these strategies, total antibiotic duration or modalities of antibiotic administrations (parenteral versus oral)^{18,44,49,50}. Other outcomes such a prosthetic stability or pain have not been investigated in relation with the duration of antibiotic therapy. A single-center evaluation specifically included the antibiotic duration in the final multivariate model and could not define a minimal duration of antibiotic prescription even when controlling

to the exchange of mobile parts (while the exchange augmented the odds for remission by two-fold)¹⁸. Another multicenter retrospective study performed in Geneva and two other centers in France directly compared infection remission after curative DAIRs between exactly six weeks and twelve weeks of post-surgical antibiotic therapy and found no difference⁴⁴. Other authors groups retrospectively found no benefit in prolonging systemic targeted antibiotic therapy beyond six weeks when the implant was left in place⁴⁵⁻⁴⁸. As we could not find either retrospective or prospective data favoring a longer treatment than for six weeks, the authors of this mini review advocate a prospective trial regarding this topic, in as much as DAIR is gaining momentum in the world of PJI management.

Conclusion

Our literature review identified fourteen retrospective studies proclaiming (or denying) the benefit of mobile parts' exchange with approximately similar study designs and methods, while the latest and the biggest studies were rather in its favor. An international consensus on DAIR from February 2019 gives the following recommendation: '*Owing to the lack of conclusive evidence in the form of well-designed prospective randomized trials and standardized protocols, only a moderate strength of recommendation is provided for exchanging the modular components during DAIR to reduce the PJI recurrence rate*'. On the other hand, the variability among definitions of remission vs. failure after treatment, the length of follow-up, different surgical techniques, and timing of DAIR after initial implantation, pathogens, antimicrobial resistance, different antibiotic protocols, different prosthesis designs, cannot be compared between studies. Logically, the choice for retention of mobile parts can be individualized, even if retrospective data demonstrates a more favorable outcome with exchange.

According to our own opinion, there are no medical downsides to the exchange of mobile parts as well as possible benefits from it. We thus routinely performed mobile parts' exchange whenever feasible within the first or second look, and without compromising the patient's being. For example, we would certainly not add another surgical intervention only just to comply with our own beliefs regarding a mobile part's exchange (in absence of other indications), when it had not been performed during the first debridement. A prospective, randomized trial able to close the debate is still needed, which would also imply the question on the duration of post-surgical antibiotic therapy.

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