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Case report

Treatment of Prosthetic Joint Infection due to *Listeria Monocytogenes*. A Comprehensive Literature Review and a Case of Total Hip Arthroplasty Infection

Vasileios Athanasiou, MD, PhD [a, *], Leonidia Leonidou, MD, PhD [b], Alexandra Lekkou, MD, PhD [b], Panagiotis Antzoulas, MD [c], Konstantina Solou, MD [c], Georgios Diamantakis, MD [a], John Gliatis, MD, PhD [d]

[a] *Consultant Orthopaedic Surgeon, Orthopaedic Department, Patras University Hospital, Patra, Greece*
[b] *Consultant in Internal Medicine, Department of Internal Medicine, Patras University Hospital, Patra, Greece*
[c] *Resident in Orthopaedic Surgery, Orthopaedic Department, Patras University Hospital, Patra, Greece*
[d] *Associate Professor in Orthopaedics, Orthopaedic Department, Patras University Hospital, Patra, Greece*

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ABSTRACT

As reported in contemporary literature, prosthetic joint infection (PJI) caused by *Listeria monocytogenes* (LM) is a rare infection affecting mainly immunocompromised patients. It is considered a late complication occurring months or years after the arthroplasty that is treated with, or without, implant retention, in one-stage or two-stage surgical procedures, and long-term administration of antibiotics. We reviewed the published studies in the English language and present a case of a patient who underwent total hip arthroplasty (THA) and had been affected by this infection. Our patient was successfully treated with 3 months of antibiotics (ampicillin and TMP/SMX) and a two-stage surgical procedure. The success rates of conservative treatment and one-stage or two-stage procedures are dependent on appropriate patient selection and chronicity of the infection. Immmunocompromised patients are susceptible to PJI caused by LM and should be advised that consumption of unpasteurized dairy products increases the risk of this atypical infection.

Introduction

Listeria monocytogenes (LM) is a Gram-positive facultative aerobic bacterium initially reported in 1926 during an animal disease epidemic. In the 1980s, it was recognized as a food-borne pathogen that can affect humans. Healthy adults can experience a mild to severe gastroenteritis due to ingestion of highly contaminated food containing up to ~10^9 bacteria. However, in the case of immunocompromised individuals, the elderly, pregnant women, and children, even lower levels of contaminated food containing up to ~10^2-10^4 bacteria can cause infection, sepsis, and complications during pregnancy with mortality rates ranging from 20% to 30% [1]. Of the 17 species of *Listeria* that have been identified, only two species, *Listeria monocytogenes* and *Listeria ivanovi*, are pathogenic for humans [1]. The rate of listeriosis in Europe and in the United States is estimated to be 4.7 cases per million people [2]. Prosthetic joint infection (PJI) caused by Listeria monocytogenes (LM) is rare and affects mainly immunocompromised patients [2-15]. In a study by Charlier et al. it was found that this atypical infection primarily involves prosthetic joints and occurs in immunocompromised patients [2]. The first case of PJI due to LM was reported in 1987 [16]. It accounts for approximately 2% of prosthetic hip and knee infections [4,17,18]. However, in recent years, PJI shows an increasing tendency because of an aging population and the increased number of immunocompromised patients undergoing joint replacement

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* Corresponding author. Consultant Orthopaedic Surgeon, Orthopaedic Department, Patras University Hospital, Hippocrates Avenue, Rio, Patras 26504, Greece. Tel.: +30 261 360 3883; +30 693 677 4403.
E-mail address: vassathanasiou@yahoo.com

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surgery [7,9,19,20]. We reviewed the published studies in the English language and present a case of a patient with total hip arthroplasty who had been affected by Listeria monocytogenes (LM).

The patient and his relatives were informed that data concerning the case would be submitted for publication, and they provided their consent.

Case presentation

An 82-year-old woman was admitted to our hospital with a recent history of a progressive right hip pain. She reported gradually increasing hip pain 4 months before her admission to the hospital. At the time of admission, the patient was afebrile, able to walk but in pain which was located at the groin area and radiated to the thigh. The patient had a total hip arthroplasty (THA) performed 9 years ago due to degenerative hip osteoarthritis. Standard hip radiographs demonstrated no obvious loosening signs of the implant (Fig. 1). She reported transitory fever and diarrhea, and that she had consumed soft cheese produced from unpasteurized milk obtained from her own animals. Nevertheless, the patient has been systematically consuming dairy products from her own animals throughout her life. White blood cells (WBCs) were 4.44K/μl, c-reactive protein (CRP) was 0.21mg/dL and erythrocyte sedimentation rate (ESR) 90 mm/1h. Paracentesis of the hip grew Listeria monocytogenes susceptible to aminopenicillins, meropenem, Sulfamethoxazole/Trimethoprim (SXM/TMP). The patient's medical history also included type 2 non-insulin dependent diabetes, chronic obstructive disease, hyperthyroidism, and hyperlipidemia.

The patient was scheduled for surgical treatment following a two-stage revision of her THA. During the first stage, we found a purulent collection mostly at the posterior aspect of the stem whereas the cup was stable (Fig. 2a and b). At the first stage, we removed the stem using controlled segmentation of the well-fixed part of the stem according to Megas et al [21]; the mobile part and the screws were removed, and a mobile-bearing spacer (Zimmer-Biomet, Warsaw, Indiana) was used (Fig. 3a and b). The patient received intravenous meropenem plus vancomycin for 2 weeks, de-escalated by intravenous ampicillin for 3 weeks, based on the culture results. She was discharged with a combination regimen of oral ampicillin and TMP/SMX and was followed-up until she underwent the second stage revision 3 months later. Before the second stage ESR was 35mm/h and CRP was < 1mg/dl. During the second-stage we removed the mobile-bearing spacer and the cup and, a tantalum cup with a Wagner stem were implanted (Zimmer-Biomet, Warsaw, Indiana). New cultures were negative. Follow-up appointments were scheduled on a monthly basis for the first 6 postoperative months, after a year postoperatively and the last took place 2 years postoperatively. On the last follow-up the patient was asymptomatic (Fig. 4a and b).

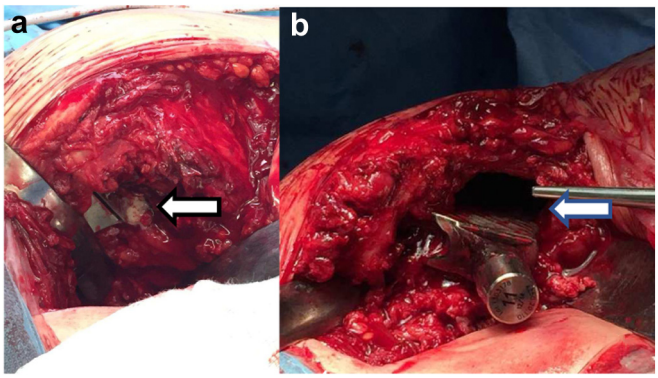

Figure 2. (a) White row shows pus collection. (b) White row shows the space after removing the pus.

Literature review

A literature search of the case reports was performed in PubMed and in Google Scholar. The criteria were "THA infection due to Listeria" and "TKA infection due to Listeria". The keywords used in our search were "Listeria monocytogenes", "Prosthetic joint infection", "THA infection due to Listeria" and "TKA infection due to Listeria". Search results were limited to articles written in the English-language. There were 33 publications; 31 were found in PubMed and 2 in Google Scholar where 67 cases were reported (the first one was reported in 1987 and the last one was reported in 2020) (Table 1) [2,3,5,20,22-36]. The median age of the patients was 65 y (range, 29-87 y), there were ~60% males and ~40% females, 20 patients (30%) had TKA infection whereas 47 patients (70%) had THA infection including our case. All cases were monoarticular infections except 1 case (1.5%) [30]. In addition, all cases were late infections with a mid-time after the arthroplasty of 6.8 years (range, 2 mo-21 y). Our literature research shows that 86.7% of the cases were immunocompromised, 7 patients (10%) reported no underlying medical condition, and furthermore in 2 patients (2.9%) there was no statement [15,31]). Charlier et al., in 43 consecutive cases reported 41 patients (95%) as being in an immunocompromised state [2]. The most commonly reported underlining medical conditions were rheumatoid arthritis followed by diabetes mellitus,

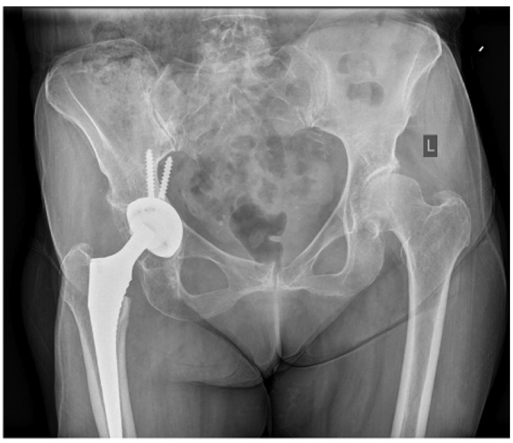

Figure 1. Radiography before surgery.

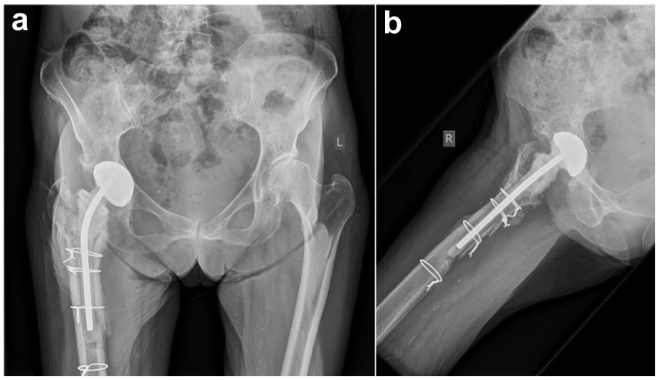

Figure 3. (a and b) Radiographs after first stage of revision.

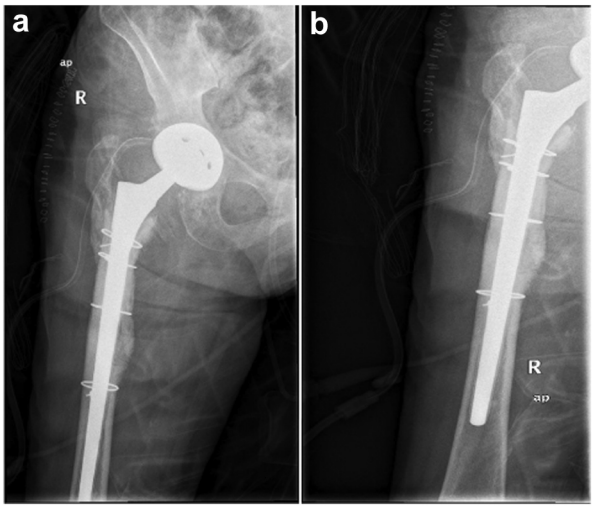

Figure 4. (a and b) Radiographs after second stage.

malignancy and transplantation cases. All cases revealed signs of local inflammatory responses and raised inflammatory markers. All patients were febrile although 20 patients (29.8%) were reported afebrile. Fluid culture positivity was reported in all except 1 case (1.5%) where the culture was reported negative [36]. All cases involved monomicrobial infections whereas 2 cases (2.9%) s aureus and s epidermis were also reported (Tables 2 and 3). The antibiotics used in most cases were ampicillin or amoxicillin (>90%) in combination with gentamicin (~50%). Surgical treatment was performed in 62% of the total cases (Table 4).

To the best of our knowledge, the present review has been the first comprehensive review of all PJIs of THA and TKA caused by LM in the English literature.

Discussion

PJI after total joint arthroplasty is a challenging complication for an orthopedic surgeon to address. Musculoskeletal Infection Society (MSIS) convened a workbook in 2011 and defined the criteria of PJI [37]. It occurs approximately at a rate of 1% to 2% of primary and in 4% of revision arthroplasties [38]. Prosthetic joint can be infected via three different pathways: perioperative, hematogenous and directly from nearby infected tissue [39]. As regards the onset time of infection postoperatively, it is classified as acute when <4 weeks (onset) and chronic when >4 weeks after surgery (delayed/low grade). Moreover, in regards to the duration of the symptoms of a hematogenous infection, they are classified as acute when the duration of symptoms is <3 weeks and chronic when the duration is >3 weeks [38,39]. The origin of hematogenous infection is reported at a rate of 32% as unknown whereas 68% as of known origin; 11% the oral cavity, 2% central venous catheters, 13% heart valves, 5% implantable electronic cardiac devices, 1% the lung, 1% the spine, 1% peripheral venous catheters, 7% the gastrointestinal tract, 12% the urinary tract, 1% other joint prostheses and the skin and 15% soft tissue [40]. The most common causative pathogen remains Staphylococcus aureus reported in up to 34% of cases, [38] followed by coagulase-negative staphylococci [15]. Listeriosis, although it is considered as self-limited gastroenteritis, does have the ability to become an invasive organism especially in the case of immunocompromised individuals, the elderly, pregnant women, and children, where even low levels of contaminated food up to ~10^2-10^4 bacteria can cause infection, sepsis, and complications of pregnancy with mortality rates ranging from 20% to 30% [1]. Epidemic listeriosis associated with the consumption of Mexican-style cheese is a well-reported phenomenon [5,41]. Most recently Paziuk et al, published a case with primary total knee arthroplasty infected with LM who had a history of consuming unpasteurized dairy products [36]. Charlier et al in their study found that this atypical infection primarily involves prosthetic joints and occurs in immunocompromised patients [2]. The PJI caused by LM is rare, referred to as less than 2% of all prosthetic joint infections [4,15,17,18]. In a recent study of 294 hips and knees, infection caused by LM was reported at a rate of 0.7%. We have found 67 cases with PJI caused by LM in English Literature (from 1987 until 2020) [2,3,5,20,22-36] (Table 1). The mid-time from initial surgery to the onset of infection caused by LM in the prior literature was 6.8 years (range, 2 mo-21 y) whereas in this case was 9 years postoperatively (Table 1 and 2). The age (older than 60 years), underlying diabetes and the presence of foreign material (THA) were the risk factors noted to be present in our patient. We successfully treated our patient with antibiotics (ampicillin and TMP/SMX) over a 3-month period, and a two-stage surgical procedure. We opted not to add an aminoglycoside, considering its nephrotoxicity as our patient had borderline renal function and we preferred TMP/SMX for synergy and its bactericidal effect with periodic monitoring of the complete blood count and renal function. A combination of ampicillin and trimethoprim-sulfamethoxazole has been employed to effectively treat severe listerial meningoencephalitis [42] and, in a recent case of prosthetic knee joint infection [6,15].

There are few publications of case reports and reviews of cases of PJIs caused by LM [2,5,11,36]. However, to the best of our knowledge, this is the first comprehensive review of all PJIs of THA and TKA caused by LM in English literature up to the year 2020. Although the diagnostic algorithm for PJIs caused by LM does not require any special consideration, we believe that a strategy is required when it comes to the treatment since it affects mainly immunocompromised patients. The duration of antibiotic therapy in our study ranges from 2 weeks of intravenous up to 6 months of per os (PO) whereas surgical treatment involves debridement, implant removal, and arthrodesis, as well as one and two-stage revision (Table 4). Ampicillin is generally considered the preferred agent, and gentamicin is added frequently for synergy especially when treating life-threatening cases of Listeria. Patients allergic to penicillin may use meropenem or SMX-TMP. Our literature review shows that 19 patients (28%) treated conservatively were reported to have good results over a 5-month to 23-month follow-up period, though one died due to cardiopulmonary arrest [2,8,10,16,18]. All cases were acute but one was chronic [9]. Cone et al. in a review published in 2001 pointed out that the recommended treatment for prosthetic joint infection caused by LM is ampicillin or penicillin alone or in combination with an aminoglycoside and TMP/SMX or vancomycin for patients allergic to penicillin [8]. Kleemann et al reported a recurrent infection 2 years after initial conservative treatment [9]. Of 9 patients (13.2%) treated with debridement 7 were reported to have good results over a 3-month to 20-month follow-up period, but 2 patients had implants removed later [5,6,14,20,24,32,33,36]. All were acute cases. Wollenhaupt et al reported that prolonged high dose antibiotic therapy and/or removal of the prosthesis may be necessary [14]. Paziuk et al. recently suggested that the duration of antibiotic therapy should be individualized [36]. In 18 patients (26.8%) one-stage revisions were applied and they were all asymptomatic over a 4-month to 3-year follow-up period with no recurrence [2,7,9,13,20,23,28,31]. All were acute cases, though two cases were chronic [9,23]. Diaz-Dilernia et al. in a recent publication of a case report and cases review, suggest that one-stage revision surgery can be more effective when compared to other surgical procedures, such as a two-stage revision surgery or debridement,

Table 1
Publications of Listeria PJIs from the first in 1987 up to 2020.

Article/Year/ Reference	Cases/Total cases	Age (y)/sex	Underlying Disease	Immunosu/sive Therapy	PJI	Time to infection after arthroplasty	Treatment surgery	Treatment antibiotic	Outcome
1) 1987 [16]	1 [1]	37/F	RT; Chronic hepatitis	Prednisolone	Hip	13y	No surgery	Iv Amp 10d; Amox	Asymptomatic 10 mo later
2) 1988 [22]	1 [2]	66/M	None	None	Hip	8mo	Two −stage revision THA	Iv Amp/Tm 2w; TMP/SMX 3 mo	Asymptomatic 18 mo later
3) 1989 [23]	1 [3]	70/M	Mitral valve replacement	None	Hip	4y	One-stage revision	Iv Amp/Tm 2w; po Amox	Asymptomatic 7 mo later
4) 1989 [24]	1 [4]	69/M	RA; Cirrhosis	None	Knee	4y	Debridement	Iv Amp 3w; po Amp 6 mo	Implant removed 6mo
5) 1990 [10]	1 [5]	64/F	RA; Cirrhosis	None	Knee	8y	No surgery	Iv Amp/Gm 6w; TMP/SMX	Asymptomatic 18 mo later
6) 1990 [25]	1 [6]	71/M	RA	None	Knee	NS	NS	Iv Amp/Gm 2w; TMP/SMX 4 mo	Asymptomatic 7 mo later
7) 1990 [26]	1 [7]	73/M	None	None	Hip	3y	NS	Iv Amp 1w; po Amp 2-3 mo	NS
8) 1990 [27]	1 [8]	66/M	DM	None	Hip	6y	NS	Iv Amp/Gm 6w; TMP/SMX	Asymptomatic 6 mo later
9) 1992 [19]	1 [9]	64/F	None	None	Hip	5mo	Implant removal	Iv Amp 10 d; Amox 1 mo	Asymptomatic 4mo later
10) 1992 [19]	1 [10]	80/F	Colon cancer	None	Knee	9y	Arthrodesis	Iv Cman/Gm 42 d	Died 2y later of colon cancer
11) 1992 [28]	1 [11]	70/M	None	None	Hip	18y	One-stage revision	Iv Amp 9w; po Amp 3w; TMP/ SMX 5w	Asymptomatic 3y later
12) 1994 [29]	1 [12]	29/M	RT	Prednisolone Azathioprine	Hip (bilateral)	6y	No surgery	Iv Amp 4w; po TMP/SMX 10 mo	Asymptomatic 23mo later
13) 1995 [18]	1 [13]	81/M	DM	None	Hip	14 y	No surgery	Iv Amp 6w; po TMP/SMX 3 mo	Asymptomatic 16 mo
14) 1996 [30]	1 [14] (AOA)	NS	DM	None	Hip	5y	Two-stage revision	Amp, Piv, TMP/SMX	Asymptomatic 6w later
15) 1997 [14]	1 [15]	70/M	RA	Methotrexate	Knee	6y	Debridement; Arthrodesis 7 w later	Iv Amp 3 w; po Amp 6 mo	Asymptomatic 12 mo later
16) 2001 [8]	1 [16]	81/M	RA	Prednisolone	Hip	4y	No surgery	Allergic to Pen; Iv TMP/SMX	Died due to cardiopulmo-nary arrest
17) 2002 [31]	1 [17] (AOA)	87/F	NS	NS	Hip	10y	One-stage revision	NS	Asymptomatic 12 mo later
18) 2003 [32]	1 [18]	51/F	RA; SLE (Colonoscopy 2 mo before)	Azathioprine Prednisolone Methotrexate	Knee	2 mo	Debridement. Implant removal later	Pen allergic; TMP/SMX problems; Cip.	NS
19) 2004 [17]	1 [19]	81/M	NR	None	Hip	NS/y	No surgery	Iv Amp 2w; po for 3 mo	Asymptomatic 18 mo later
20) 2006 [33]	1 [20]	67/F	RA	Prednisolone Methotrexate	Knee	5y	Debridement	In Amp/Gen 5 w	Asymptomatic 3 mo later
21) 2007 [34]	1 [21]	79/M	RA	Glucocorticoids Methotrexate Infliximab	Hip	NS/Y	Debridement	Iv Amp 2 w; Rif/ Gen intolerance; Amox	Asymptomatic 5 mo
22) 2008 [11]	1 [22] (2nd 2001)	71/F	RA	Corticosteroid	Hip	NS	NS	Amp	Asymptomatic mo later
23) 2008 [35]	1 [23]	73/M	RA	Not on steroids	Hip	NS (L.M and S. aureus)	Two-stage revision	Flu 10 d; iv tei/rif 6 w	NS
24) 2009 [9]	1 [24]	63/F	Leiomyosarcoma distal femur	None	Knee	5 mo 1st admission 2y 2nd admission	One-stage revision; 2 y after initial conservative treatment	1st. Amp allergy; Lev/ co-t 2nd Lin 4w, Rif for 3 mo and Co-t 4 mo	Asymptomatic 4 mo later
25) 2011 [12]	1 [25]	78/M	None	None	Hip	11y (L.M. and Staph. E.)	Two-stage revision	Iv Amp for 4 days; po Amp for 3 mo	Asymptomatic 2y later

(*continued on next page*)

Table 1 (*continued*)

Article/Year/ Reference	Cases/Total cases	Age (y)/sex	Underlying Disease	Immunosu/sive Therapy	PJI	Time to infection after arthroplasty	Treatment surgery	Treatment antibiotic	Outcome
26) 2012 [2]	34 [59] 34/43 (1992-2010 FNRCL)	Age was 72 (range, 16–89)/ 61% M	79% (NS particularly for Arth/sty)	79% (NS particularly for Arth/sty)	Hip 26 Knee 8	9y median time	- 12 one-stage revision - 2 two-stage revision - 5 removal - 13 no surgery - 2 NS	Primarily Amox 80% with Ami 48% for median duration 15w	Asymptomatic 5 mo later
27) 2015 [5]	1 [60]	72/F	Polymyalgia rheumatic	Prednisone	Knee	2y	Debridement	Iv Amp 6w; po Amox 6 mo	Asymptomatic mo later
28) 2016 [6]	1 [61]	61/M	DM; Cushing syndrome	Prednisolonemg Fludrocortisone	Knee	2y	Debridement	Iv Amp/ TMP/SMX 6w; po Amox/ TMP/ S MX for 7 w	Asymptomatic several months later
29) 2018 [13]	1 [62]	78/F	Rectal cancer	None	Hip	21y	One-stage revision with the diagnosis of aseptic loosening	Van prophylaxis (Implant microbiological analysis LM)	Asymptomatic 6 mo later
30) 2018 [3]	1[63]	69/M	DM. Anemia, Hypertension	None	Knee	3w	Debridement, mobile parts were replaced	Iv Amox/2w folloed by TMP/SMX/10w	Asymptomatic 1y later
31) 2019 [20]	1 [64]	50/M	None	None	Hip	9 mo	Debridement, mobile parts were replaced	Iv Amp/Rif 13 d; po Lev/Fif for 3 mo	Asymptomatic 20 mo later
32) 2019 [7]	1 [65]	77/F	None	None	Knee	5y	One-stage revision	Iv Amp for 1w; TMP/SMX 6w po Amox 7w	Asymptomatic 2y later
33) 2019 [15]	2 [66]	NS	NS	NS	1Hip/1Knee	NS	NS	NS	NS
34) 2020 [36]	1 [67]	67/F	DM, Asthma, Psoriatic arthritic	Methotrexate 15mg & Methilprednisol-one 2mg	TKA	4mo	Debridement, mobile parts were replaced	Iv & po Amp/Rif 6w; 2mo TMP/SMX	Asymptomatic 1y later
35) 2021	1 [68] PR	82/F	DM, Hyperthyroidism, Hyperlipidemia, Chronic obstructive disease	None	Hip	9y	Two-stage revision	Iv MR/VAN 1w; Iv Amp 3w; po 8w Amp/TMP/SMX	Asymptomatic 2y later

Amox, amoxicillin; Amp, ampicillin; Pen, Penicillin; Piv, Pivapicillin; Cefo, cefoxitin; Cefa, cefamandole; Gen, gentamicin; Tob, tobramycin; TMP/SMX, trimethoprim/sulfamethoxazole; Rif, rifampicin; Lev, levofloxacin; Ami, aminoglycosides; Cip, ciprofloxacin; Flu, flucloxacillin; Tei, teicoplanin; Lin, linezolid; Co-t, co-trimoxazole; Van, vancomycin; MR, meronem; RA, rheumatoid arthritis; N, neoplasmas; DM, diabetes mellitus; RT, renal transplant; CRF, chronic renal failure; THA, total hip arthroplasty; HA, hemiarthroplasty; TKA, total knee arthroplasty; NS, not stated; PR, present report; AOA, abstract only available; FNRCL, French National Reference Center for Listeria.

Table 2
Epidemiologic of Listeria PJIs.

Age
Range, 29-87 y (65 y)
Gender predominance
Male-dominated (6:4)
Number of joint
Monoarticular infection in all cases but 1 (1.5%)
Hip/Knee joint
Hips are 70% / knees 30% (20/68)
Time from surgery arthroplasty to infection
All late infections with a mid-time 6.8 y (range, 2 mo-21 y)
Medical condition all cases but 9 (13.2%)
Rheumatologic disorders
Chronic hepatitis
Cirrhosis
Lymphoid and hematopoietic neoplasms
Solid organ neoplasms
Renal transplantation
Diabetes mellitus
Chronic renal failure
Alcoholism
Human immunodeficiency virus infection
Mitral valve replacement
None known
Immunosuppressive medications (~31%)
Corticosteroids
Methotrexate
Cyclosporine
Azathioprine
Mycophenolate mofetil
TNF-α inhibitors (infliximab, etanercept)

antibiotics, and implant retention (DAIR) [7]. They mention that key factors for the successful treatment of one-stage revision surgery for chronic PJI in TKA are preoperative diagnosis, known susceptibility of the microorganism, aggressive debridement after a standardized surgical protocol, and the combination of local and systemic antibiotics (ATB) therapy [7]. Our literature review shows no recurrent cases from one-stage revisions. In 7 patients (10%), two-stage revision shows good results over a 5-month to 2-year follow-up period [2,11,12,22,30,35 and our case] (Tables 1 and 4). All cases were chronic though two were acute [2,11]. Nevertheless, it is an additional surgical procedure compared to one-stage

Table 3
Clinical features of Listeria PJIs.

Clinical presentation
Local signs: pain, erythema, effusion, and decreased range of motion Systemic signs: fever: 20 (29.8%)
High Risk Foods
Unpasteurized milk
Queso fresco (other soft cheeses
Row sprouts
Melons (if non refrigerated for greater than 4 hours or older than 7 days)
Lunch meats and cold cuts
Pates
Hot dogs
Smoked seafood
Diagnosis
Laboratory
Leukocytosis, anemia, elevated CRP level
Synovial fluid
Leukocytes (mean 15,100 mm^3, 84% polymorphonuclear cells)
Microbiologic
Bacteremia (positive <20% of time)
L. monocytogenes isolated from prosthetic joint in all cases but 1 (1.5%)
All monomicrobial infections but 2 (2.9%) had in additional s aureus and e epidermis
Imaging
Prosthesis loosening, bone resorption, intra-articular collection
Periarticular abscess

Table 4
Antibiotics and surgical treatment of Listeria PJIs.

Antibiotic therapy
Agent (intravenous and oral)
Ampicillin or amoxicillin (>90% of time)
Gentamicin combination (~50% of time)
Trimethoprim-sulfamethoxazole (TMP/SMX)
Vancomycin
Duration of therapy
Variable (range from 2w iv up to 6mo po)
Surgical treatment all but 19 (29.8%) & 7 (10.4%) non statement
Debridement 9 (13.3%)
Prosthesis removal-Arthrodesis 7 (10.4%)
1-stage revision 18 (26.8%)
2-stage revision 7 (10.4%)
Failure: 8 (11.9%) from non-implant removal cases

revision. In regards to the surgical treatment of our patient, one-stage or two-stage revision of the THA was debatable. On the basis of our study, the one-stage revision of the THA could have been an equally effective treatment.

Of all patients 19 (28%) were treated conservatively and for 7 (10%) there was no statement (Table 4). We think that the success rates of conservative treatment, one-stage or two-stage procedures are dependent on selecting appropriate patients having considered acute and chronic infections, and other individual factors.

Based on our study, although the number of patients is limited, we believe that PJIs caused by LM after THA and TKA can be treated with debridement and mobile part replacement if the implant is stable or with one-stage procedures with suitable antibiotics (ATB) and proper time administration.

Conclusions

Although the diagnostic algorithm for PJI caused by LM does not require any special consideration, a strategy is vital when considering prevention and treatment since it affects especially immunocompromised patients. Ampicillin is generally considered the preferred agent in combination with gentamicin. Meropenem or SMX-TMP have been suggested for patients allergic to penicillin. A combination of ampicillin and trimethoprim-sulfamethoxazole seems to be an option for severe infections. The time of antibiotic administration, conservative or surgical treatment, debridement and prothesis retain or removal in one or two-stages revision remain controversial. Surgical treatment was performed in 42 patients (62%), 19 patients (28%) were treated conservatively and for 7 (10%) there was no statement. Our literature review shows no recurrent cases from one-stage revisions. The present study shows, that this type of infection can be treated with debridement, and mobile part replacement if it is stable or one-stage revision with suitable antibiotics and proper time administration. Immmunocompromised patients are susceptible to PJI caused by LM and should be advised that consumption unpasteurized dairy products increases the risk of this atypical infection.

Acknowledgment

None

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Patient consent

The patient and his relatives were informed that data concerning the case would be submitted for publication, and they provided their consent.

Informed patient consent

The author(s) confirm that informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

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