Diluted Povidone-Iodine Lavage in Total Hip and Knee Replacement: A Retrospective Comparative Study

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ABSTRACT

Introduction: One of the prophylactic techniques to reduce the incidence of periprosthetic infections is dilute povidone-iodine lavage, an agent with bactericidal action against different microorganisms. The purpose of this study was to evaluate the incidence of periprosthetic infections within the first 90 days in patients who had undergone povidone-iodine lavage after implantation of prosthetic components and before wound closure. **Materials and Methods:** A comparative retrospective study was performed on patients who had undergone primary total hip or knee replacement due to advanced joint osteoarthritis between October 1999 and April 2020. We assessed the PJI rate between two cohorts: Group A, which consisted of patients who received povido ne-iodine lavage routinely, and Group B, where this solution was not applied. **Results:** 643 (47.60%) knee replacements and 708 (52.40%) hip replacements were performed. When comparing the incidence of periprosthetic infections between both groups, no statistically significant differences were observed (0.92% vs. 0.21%; p = 0.11). However, the risk of infection was increased in the first 90 days after surgery (OR = 4.5; 95% CI 0.56-36.19) when the solution was not used. **Conclusions:** The risk of developing periprosthetic infections increased 4.5 times when performing an arthroplasty without irrigation with diluted povidone-iodine. However, this could not be shown to be statistically significant.

Keywords: Joint infection; hip revision; knee revision; povidone-iodine; betadine.

Level of Evidence: III

Lavado con povidona yodada diluida en el reemplazo articular de cadera y rodilla para prevenir infecciones: estudio retrospectivo comparativo

RESUMEN

Introducción: Una de las medidas profilácticas para disminuir la incidencia de infecciones periprotésicas es el lavado con povidona yodada diluida, un agente con acción bactericida contra distintos microorganismos. El propósito de este estudio fue evaluar la incidencia de infecciones periprotésicas dentro de los primeros 90 días, en pacientes a quienes se les realizó un lavado con povidona yodada luego de implantar los componentes protésicos y antes del cierre de la herida. **Materiales y Métodos:** Se llevó a cabo un análisis retrospectivo comparativo de pacientes sometidos a artroplastias primarias de cadera y rodilla por artrosis y se comparó la indicencia de infecciones periprotésicas dentro de los primeros 90 días posoperatorios, entre pacientes que fueron operados antes de la introducción del lavado con povidona yodada y luego con su uso rutinario. **Resultados:** Se realizaron 643 (47,60%) reemplazos de rodilla y 708 (52,40%) reemplazos de cadera. Al comparar la incidencia de infecciones periprotésicas entre ambos grupos, no se observaron diferencias estadísticamente significativas (0,92% vs. 0,21%; p = 0,11). Sin embargo, se incrementó el riesgo de infección en los primeros 90 días posteriores a la cirugía (OR = 4,5; IC95% 0,56-36,19) cuando no se utilizó la solución. **Conclusiones:** El riesgo de desarrollar infecciones periprotésicas se incrementó 4,5 veces al realizar una artroplastia sin irrigación con povidona yodada diluida. Sin embargo, no se pudo demostrar que esto fuese estadísticamente significativo.

Palabras clave: Artroplastia de cadera; artroplastia de rodilla; infección periprotésica; povidona yodada.

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INTRODUCTION

Thanks to advances in designs and the excellent long-term outcomes demonstrated, primary knee and hip arthroplasties represent one of the most frequent and fastest growing procedures in the last decade.[1] In the United States, it is estimated that more than 1 million hip and knee replacements are performed each year.[2] However, these procedures are not exempt from complications and one of the most challenging is periprosthetic infection (PPI).

Different prevention strategies have been described, such as proper hand washing, the use of disposable sterile fields, careful preparation of the skin, and antibiotic therapy.[3,4] However, PPIs account for up to 14% of hip revision causes and 25% of knee revision causes.[5]

Springer et al. conducted a study to analyze the data published by six major international registries (New Zealand, Sweden, Wales, Australia, Northern Ireland, and the United States) and found that the risk of developing chronic PPI after hip arthroplasty varies from 0.76% to 1.24%, while, in the case of the knee, the percentage ranges between 0.88% to 1.28%.[6]

Povidone-iodine (PVP-I) is a complex of povidone, hydrogen iodine, and elemental iodine. Since the latter is highly soluble in water, its slow release in an aqueous medium produces a wide spectrum of antimicrobial activity against bacteria, protozoa, fungi and viruses, through the iodination of their lipids and oxidation of their cytoplasmic and membrane components.[7,8] It also inhibits the formation of staphylococcal biofilms and there are no reports of acquired resistance.[7]

Although, in previous studies, it was not possible to demonstrate a significant difference in the rate of PPIs with the use of diluted PVP-I,[9] there are other reports that maintain that its use managed to reduce the incidence of PPIs in the hip or knee during the first 90 days.[10,11]

The purpose of this study was to compare the incidence of PPIs of the hip and knee in the first 90 days after surgery between a group of patients in whom routine PVP-I lavage was used and another group who had not undergone this procedure. Our hypothesis is that the PPI rate in the first 90 days in patients with PVP-I lavage is lower than that of patients who do not undergo this procedure.

MATERIALS AND METHODS

We carried out a retrospective analysis of patients operated on at our institution between October 1999 and April 2020. Patients who had undergone primary knee or hip arthroplasty due to a diagnosis of severe osteoarthritis and who completed a minimum follow-up of 90 days were included. Patients with simultaneous bilateral arthroplasties or who had received radiotherapy, chemotherapy or biological agents were excluded.

Two groups were formed: group A with patients operated on before December 2015, before the introduction of PVP-I lavage, and group B with patients to whom this solution had been applied, as a routine, before wound closure. In all cases, demographic data, such as age, gender, and side of the limb involved, were recorded. In hip arthroplasties, it was also documented whether it was a cemented, hybrid or uncemented replacement.

In both groups, the PPI rate was calculated within the first 90 days after surgery. PPI was defined based on the criteria described by the Second Philadelphia Consensus.[12] The microorganisms that caused the infection were also documented.

Data were recorded by a fellow trained in reconstructive orthopedic surgery of the lower limb.

Postoperative controls were performed at 3 and 6 weeks, and at 3 months.

Surgical technique

All patients were operated on by the same surgeon, in a laminar flow operating room, under hypotensive spinal anesthesia. Patients undergoing knee replacement underwent peripheral femoral nerve block prior to admission to the operating room and were operated on with a hemostatic cuff. Antibiotic prophylaxis with 1 g of cefazolin (2 g, >80 kg) was administered up to 30 min before skin incision. If the patient was allergic to cephalosporins, clindamycin was indicated.

As antithrombotic prophylaxis, tranexamic acid 20 mg/kg was administered before the procedure.

In all cases, a direct anterolateral approach was used, according to the modified Hardinge approach, and in the knee arthroplasties, an internal parapatellar arthrotomy was performed. The addition of antibiotics to the cement was selective in patients with risk factors (body mass index >35 or diabetics).

To prepare the solution, 20 cc of PVP-I (Pervinox®: PVP-I 10g/100 ml) are used with 500 cc of physiological solution in a closed and sterile bag, which results in a formula diluted to 0.38%.

After implanting the prosthetic components and before closing the wound, the tissues were covered with the aforementioned solution for 3 min, timed by the circulating nurse in the operating room. Lastly, the solution was aspirated and the wound was closed by planes (Figure).

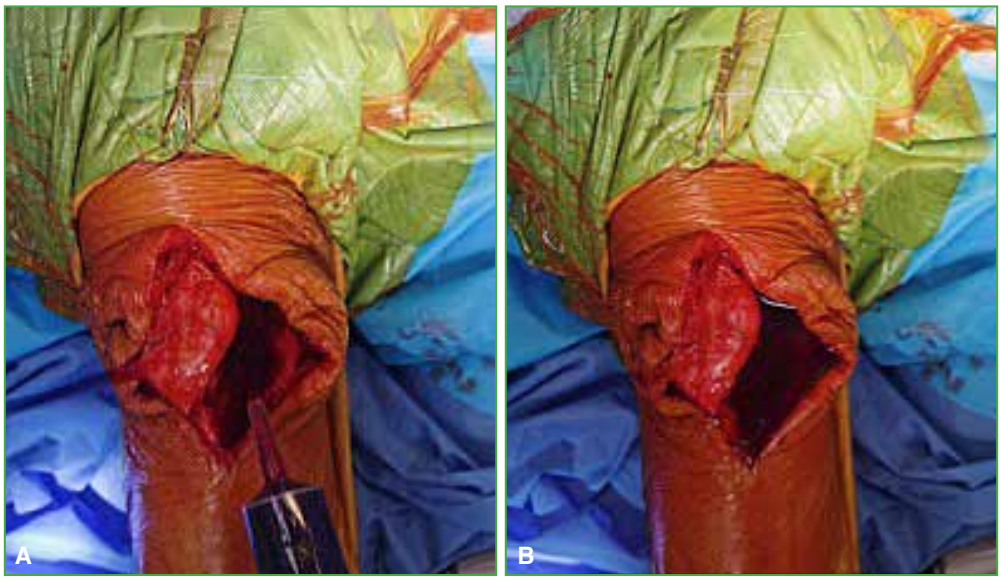

Figure. A. Administration of 520 ml of povidone-iodine solution. **B.** It remains in suspension for 180 seconds in the joint cavity.

Rehabilitation protocol

The patients began their rehabilitation using the same protocol under the strict control of a member of the Kinesiology Department. The same day of the surgery they started sitting on the edge of the bed and the limb was allowed to flex up to 90º. On the second day, gait rehabilitation was carried out using a walker as assistance. The next day, the patients walked with two Canadian crutches and, if there were no complications, their use was extended during the first three weeks. From week 3 to week 6, they used a cane, after which they walked unassisted.

Statistical Analysis

Quantitative variables are described as mean and standard deviation, and categorical variables as percentage and absolute value. Differences in continuous variables between groups were compared with Student's t-test, and categorical variables were assessed by the X^2 test. A p value <0.05 was considered statistically significant.

Univariate logistic regression was performed to evaluate the association between the use of lavage with diluted PVP-I and PPI, considering a p value <0.05 as significant. In addition, the independent contribution of age and development to PPI was assessed by constructing a multivariate logistic regression analysis. All data were entered into an Excel® spreadsheet (Redmond, USA) and the GraphPad Prism® 8.0 program (LaJoya, CA, USA) was used for statistical calculations.

RESULTS

A total of 1,356 arthroplasties were performed in 1,356 patients during the period described. Five were excluded for not completing the minimum follow-up required for the study, for which the series was finally made up of 1,351 arthroplasties. 643 (47.60%) total knee replacements and 708 (52.40%) total hip replacements were performed.

A total of 560 (41.45%) men were treated and the overall average age of the series was 68.53 ± 9.44.

Table 1 details the demographic data of the patients in both groups. There were no statistically significant differences in the mean age and sex in both groups.

Table 1. Demographic data of the patients included in the study.

	Group A	Group B	p
Number of patients (%)	866 (64.1)	485 (35.9)	
Sex (%) Male Female	 369 (42.61) 497 (57.39)	 191 (39.38) 294 (60.62)	0.24
Side (%) Right Left	 470 (54.34) 395 (45.66)	 253 (52.16) 232 (47.84)	0.44
Age (standard deviation)	68.39 ± 9.45	68.77 ± 9.42	0.48

When comparing the incidence of PPI and PVP-I lavage, no statistically significant differences were observed (0.92% vs. 0.21%; p = 0.11) (Table 2).

Table 2. Overall incidence of periprosthetic infection with or without diluted povidone-iodine lavage

	Total	Periprosthetic infection	%	p
Group A	866	8	0.92	0.11
Group B	485	1	0.21	

When analyzing each group, it was observed that there was no statistically significant difference in the prevalence of PPIs between hip and knee arthroplasties (Table 3).

Table 3. Incidence of periprosthetic infection in hip and knee arthroplasty

Surgery	Lavage	No periprosthetic infection (%)	Periprosthetic infection (%)	p
Total knee replacement	Without PVP-I solution	348 (98.9)	4 (1.1)	0.13
	With PVP-I solution	291 (100.0)	0 (0.0)	
Total hip replacement	Without PVP-I solution	432 (99.1)	4 (0.9)	0.65
	With PVP-I solution	271 (99.6)	1 (0.4)	

PVP-I = Povidone-iodine

An increased risk of infection in the first three months after surgery (odds ratio [OR] = 4.5, 95% CI 0.56-36.19) was found in patients without lavage. When adjusting the risk with the age variable, a similar result was obtained (OR = 4.6; 95% CI 0.57-37.07).

The average age of the patients when the infection was diagnosed was 73.1 ± 11.9 years (range 48-86), with a mean of 6.9 ± 1.1 (range 6-9).

The diagnosis of infection and surgical debridement were made 33 ± 5.7 days (range 26-74) after the primary arthroplasty. Secretion from the wound, dehiscence and erythema, together with pain (77.7%) were the most frequent signs that led to the diagnosis.

All patients diagnosed with infection had positive cultures and the most frequent microorganism isolated was *Staphylococcus epidermidis* (66.7%) by puncture or intraoperative sample; in two cases, *Staphylococcus aureus* (22.2%) was isolated and, in one patient (11.1%), *Proteus mirabilis*.

DISCUSSION

The most important finding of our study was an increased risk of infection within 90 days after surgery (OR = 4.5; 95% CI 0.56-36.19) in patients who had not received 0.38% diluted PVP-I lavage. Although the PPI rate decreased with the use of this solution, this did not represent a statistically significant difference (0.92% vs. 0.21%; p = 0.11).

Multiple interventions have been published to reduce the risk of infection during and after arthroplasty, for example, reducing the staff circulating in the operating room, positive pressure ventilation with laminar flow, and control of factors inherent to the patient (perioperative blood glucose values, body mass index, anemia or immunosuppression).[13,14]

The use of antiseptic agents in preoperative lavage has cytotoxic effects on bacteria in surgical wounds; however, these agents can injure host tissue, increasing the rate of wound complications.[15] von Keudell et al. evaluated the harmful effect of different concentrations of PVP-I on bovine tissues and found that the 0.35% dilution was the one that caused the least harmful effects on the host.[16]

In 2010, Brown et al. demonstrated a decrease in the PPI rate with the use of PVP-I diluted to 0.35%.[10] They reported 18 cases (0.97%) of infection within the first 90 days before the use of diluted PVP-I and only one (0.15%) after its application. Thus, its use has begun to spread in other institutions.[17]

Recent studies have reported on the results of intraoperative lavage protocols during arthroplasties, comparing the use of chlorhexidine, vancomycin powder and PVP-I, the latter having higher bactericidal power than the others.[18]

In 2019, Hernandez et al.[19] published an analysis of 11,738 hip and knee arthroplasties in which they compared surgeries with systematic irrigation of PVP-I diluted to 0.25% before closing the wound, with another group in which physiological solution was used. There were no statistically significant differences in the PPI rate at three months, but a decrease in events was observed within one year.

Perhaps one of the studies with the best level of evidence published in this regard was that of Calkins et al., who carried out a randomized controlled trial that included 234 patients (153 knees and 81 hips) who received intraoperative irrigation with physiological solution and were compared with 223 patients (144 knees and 79 hips) who underwent lavage with PVP-I diluted at 0.35%. There was a statistically significant decrease in infections (3.4% vs. 0.4%; p = 0.03) within three months after arthroplasty. Because of these results they felt an ethical obligation to conclude the study earlier than planned.[11]

Although a statistically significant decrease could not be demonstrated in our series, the difference in the PPI rate after the introduction of the diluted PVP-I lavage (0.92% vs. 0.21%) suggests that there could be a tendency to reduce the development of an infectious complication within the first 90 postoperative days. In addition, we were able to observe that the risk of developing PPI in the early postoperative period increased 4.5 times in patients without systematic irrigation with this solution (OR = 4.5; 95% CI 0.56-36.19).

In a recent systematic review and meta-analysis of seven studies involving 31,213 hip or knee arthroplasties, Kim et al.[20] found no significant differences in the rate of PPI between patients who received PVP-I irrigation before wound closure and those who did not.

We consider that PVP-I lavage represents a simple, low-cost method without consequences for the host tissue. Based on the results obtained in our study with a large number of cases, we suggest its routine use.

The limitations of our study are its retrospective design, the low number of events and the lack of a meticulous analysis of the previous comorbidities of each of the patients that could influence the development of the infection and constitute a confounding factor. However, we consider that the number of patients included, the homogeneity of the population, and the fact that all cases were operated on by the same surgeon allowed us to perform an appropriate statistical analysis. It should be noted that, to our knowledge, this is the first national study in this regard and invites us to carry out research with more appropriate designs that allow conclusions to be drawn with a better level of evidence.

CONCLUSIONS

Irrigation with 0.38% diluted PVP-I after component placement and prior to wound closure in hip and knee arthroplasty decreased the rate of PPI within the first 90 days, with no statistically significant association (0.92% vs. 0.21%; p = 0.11). However, the risk of developing an infection was 4.5 times higher in patients without PVP-I lavage.

Conflict of interest: The authors declare no conflicts of interest.

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REFERENCES

1. Fingar KR, Stocks C, Weiss AJ, Steiner CA. Most frequent operating room procedures performed in U.S. hospitals, 2003–2012: Statistical Brief #186. En: *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Agency for Healthcare Research and Quality (US), Rockville (MD); 2006. PMID: 25695123
2. American Joint Replacement Registry. American Joint Replacement Registry 2017 annual report figures. [cited 2019 Jan 17]. http://www.ajrr.net/publications-data/ annual-reports.
3. Kapadia BH, Johnson AJ, Hbsc JAD, Issa K, Mont MA. Pre-admission cutaneous chlorhexidine preparation reduces surgical site infections in total hip arthroplasty. *J Arthroplasty* 2013;28(3):490-3. https://doi.org/10.1016/j.arth.2012.07.015
4. Albuhairan B, Hind D, Hutchinson A. Antibiotic prophylaxis for wound infections in total joint arthroplasty A systematic review. *J Bone Joint Surg Br* 2008;90(7):915-9. https://doi.org/10.1302/0301-620X.90B7.20498
5. Kapadia BH, Berg RA, Daley JA, Fritz J, Bhave A, Mont MA. Periprosthetic joint infection. *Lancet* 2015;6736(14):1-9. https://doi.org/10.1016/S0140-6736(14)61798-0
6. Springer BD, Cahue S, Etkin CD, Lewallen DG, Mcgrory BJ. Infection burden in total hip and knee arthroplasties: an international registry-based perspective. *Arthroplasty Today* 2017;3(2):137-40. https://doi.org/10.1016/j.artd.2017.05.003
7. Oduwole KO, Glynn AA, Molony DC, Murray D, Rowe S, Holland LM, et al. Anti-biofilm activity of sub-inhibitory povidone-iodine concentrations against Staphylococcus epidermidis and Staphylococcus aureus. *J Orthop Res* 2010;28(9):1252-6. https://doi.org/10.1002/jor.21110
8. Bigliardi PL, Abdul S, Alsagoff L, El-kafrawi HY, Pyon K, Tse C, et al. Povidone iodine in wound healing: A review of current concepts and practices. *Int J Surg* 2017;44:260-8. https://doi.org/10.1016/j.ijsu.2017.06.073
9. Hart A, Hernandez NM, Abdel MP, Mabry TM, Hanssen AD, Perry KI. Povidone-iodine wound lavage to prevent infection after revision total hip and knee arthroplasty. *J Bone Joint Surg Am* 2019;101(13):1151-9. https://doi.org/10.2106/JBJS.18.01152
10. Brown NM, Cipriano CA, Moric M, Sporer SM, Valle CJ Della. Dilute Betadine lavage before closure for the prevention of acute postoperative deep periprosthetic joint infection. *J Arthroplasty* 2012;27(1):27-30. https://doi.org/10.1016/j.arth.2011.03.034

11. Calkins TE, Culvern C, Nam D, Gerlinger TL, Levine BR, Sporer SM, et al. Dilute Betadine lavage reduces the risk of acute postoperative periprosthetic joint infection in aseptic revision total knee and hip arthroplasty: A randomized controlled trial. *J Arthroplasty* 2020;35(2):538-41.e1. https://doi.org/10.1016/j.arth.2019.09.011
12. Parvizi J, Gehrke T. Segundo Consenso Internacional sobre Infecciones Musculoesqueléticas. Imaidea In. 2018, pág. 365.
13. Johnson AJ, Kapadia BH, Molina CB, Mont MA, Daley JA. Chlorhexidine reduces infections in knee arthroplasty. *J Knee Surg* 2013;26(3):213-8. https://doi.org/10.1055/s-0032-1329232
14. Leaper DJ, Surgery E, Edmiston CE, Surgery E. WHO: global guidelines for the prevention of surgical site infection. *J Hosp Infect* 2017;95(2):135-6. https://doi.org/10.1016/j.jhin.2016.12.016
15. Driesman A, Shen M, Feng JE, Waren D, Slover J, Bosco J, et al. Perioperative chlorhexidine gluconate wash during joint arthroplasty have equivalent PJI rates in comparison to Betadine wash. *J Arthroplasty* 2020;35(3):845-8. https://doi.org/10.1016/j.arth.2019.10.009
16. von Keudell A, Canseco JA, Gomoll AH. Deleterious effects of diluted povidone – iodine on articular cartilage. *J Arthroplasty* 2013;28(6):918-21. https://doi.org/10.1016/j.arth.2013.02.018
17. Jiranek WA, Waligora AC, Hess SR, Golladay GL. Surgical treatment of prosthetic joint infections of the hip and knee: Changing paradigms? *J Arthroplasty* 2015;30(6):912-8. https://doi.org/10.1016/j.arth.2015.03.014
18. Cichos KH, Andrews RM, Wolschendorf F, Narmore W, Mabry SE, Ghanem ES. Efficacy of intraoperative antiseptic techniques in the prevention of periprosthetic joint infection: Superiority of Betadine. *J Arthroplasty* 2019;34(7):S312-8. https://doi.org/10.1016/j.arth.2019.02.002
19. Hernandez NM, Hart A, Taunton MJ, Osmon DR, Mabry TM, Abdel MP, et al. Use of povidone-iodine irrigation prior to wound closure in primary total hip and knee arthroplasty. *J Bone Joint Surg* 2019;101(13):1144-50. https://doi.org/10.2106/JBJS.18.01285
20. Kim C, Kim H, Lee SJ, Yoon JY, Moon J, Lee S, et al. The effect of povidone-iodine lavage in preventing infection after total hip and knee arthroplasties: Systematic review and meta-analysis. *J Arthroplasty* 2020;35(8):2267-73. https://doi.org/10.1016/j.arth.2020.03.004