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Original Research Article

COMPARATIVE STUDY OF PERIPROSTHETIC OSTEOLYSIS IN PARTIAL HIP REPLACEMENT: IMPACT OF COOLED VERSUS ROOM TEMPERATURE SALINE LAVAGE DURING CEMENTING IN CENTRAL INDIA

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Abstract
Periprosthetic osteolysis is a well-recognized complication after cemented partial hip replacement that may lead to aseptic loosening and revision surgery. This prospective study compared the effect of cooled saline lavage (2°C–8°C) versus room temperature saline lavage (25°C–27°C) during cementing on intraoperative hemodynamic parameters and the long-term incidence of periprosthetic osteolysis in elderly patients with fracture neck of femur. Thirty patients (aged 55–70 years) were allocated into two groups based on the saline temperature used during cementing. Intraoperative vital signs were recorded before and 12 minutes after cement insertion, and radiological evaluations were performed at multiple follow-up intervals up to 1 year. The cooled saline group showed more stable vital parameters and a trend toward lower rates of osteolysis compared with the room temperature group. These findings suggest that using cooled saline during cementing may reduce the thermal effects of PMMA polymerization and improve the biological response, thereby minimizing periprosthetic osteolysis.

INTRODUCTION

Hip fractures, particularly femoral neck fractures, are common among the elderly and are associated with high morbidity and mortality rates. Partial hip replacement (hemiarthroplasty) is the preferred surgical intervention for displaced femoral neck fractures in this age group, especially in the presence of osteoporosis.[1] Cemented fixation using polymethyl methacrylate (PMMA) remains a gold standard for securing implants; however, the exothermic polymerization reaction of PMMA can generate high interface temperatures that may lead to thermal injury of the surrounding bone.[2,3]
Thermal damage to bone tissue has been implicated in the development of periprosthetic osteolysis—a process characterized by progressive bone resorption around the implant, eventually contributing to aseptic loosening.[4,5] Prior studies have shown that high cement mantle temperatures may not only alter the mechanical properties of the bone–cement interface but also trigger a cascade of inflammatory responses that exacerbate bone resorption.[6,7] Various strategies have been proposed to mitigate these adverse effects, including modifications to cementing techniques and the use of cooled lavage to lower the initial temperature of the cement mixture during insertion.[8,9]
This study was designed to compare the effects of using cooled saline lavage versus room temperature saline lavage during cementing on both intraoperative hemodynamic parameters and the long-term incidence of periprosthetic osteolysis in patients undergoing cemented partial hip replacement in Central India.

MATERIALS AND METHODS

Study Design and Setting: A prospective study was conducted in the Department of Orthopaedics, N.S.C.B. Medical College & Hospital, Jabalpur (M.P.), Central India, from January 2021 to June 2022.
Patient Selection: Thirty patients aged 55–70 years with fracture neck of femur and underlying osteoporosis were enrolled. Patients undergoing revision procedures or those with systemic diseases causing secondary osteoporosis were excluded.

Grouping and Intervention

Patients were divided into two groups:

- Group A (Cooled Saline): Lavage with saline maintained at 2°C–8°C.
- Group B (Room Temperature Saline): Lavage with saline at 25°C–27°C.

All patients underwent cemented modular bipolar hemiarthroplasty. The cementing process was performed using a cement gun. Intraoperative vital signs—axillary body temperature, systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate, and oxygen saturation (SpO_2)—were recorded immediately before cementing and 12 minutes after cement insertion.

Radiological Evaluation: Follow-up radiographs (anteroposterior and lateral views) were obtained at 4 weeks, 6 months, 9 months, and 1 year postoperatively to assess for periprosthetic osteolysis.

Statistical Analysis: Data were expressed as mean ± standard deviation. Group comparisons were performed using the t-test, with significance set at $P < 0.05$.

RESULTS

Demographic and Injury Characteristics: A total of 30 patients were included in the study. The demographic distribution was as follows:

- Sex Incidence: 17 males (56.7%) and 13 females (43.3%).
- Mode of Injury: Most patients sustained a fracture due to a fall on ground (56.7%), followed by falls from stairs (30%), falls from a bike (10%), and falls from height (3.3%).
- Side of Fracture: The right side was involved in 63.3% of cases, and the left side in 36.7%.

[Table 1 and Table 2] (see below) summarize these demographic and injury-related characteristics.

Intraoperative Hemodynamic Parameters

Vital parameters were recorded before cementing and 12 minutes after cementing for both groups. Key findings include:

- Pre-cementing: Both groups had comparable body temperature, SBP, DBP, pulse rate, and SpO_2.
- Post-cementing: The cooled saline group (Group A) demonstrated significantly better preservation of SBP (112.71 ± 3.51 mmHg vs. 94.37 ± 8.34 mmHg; P = 0.001), lower changes in pulse rate (79.21 ± 7.72 bpm vs. 72.81 ± 7.73 bpm; P = 0.001), and smaller reductions in SpO_2 compared with the room temperature group (97.21 ± 0.57% vs. 93.93 ± 0.25%; P = 0.001). A slight rise in body temperature was noted in both groups but remained within acceptable limits.

[Table 3] presents a detailed comparison of these parameters.

Radiological Outcomes

At the 1-year follow-up, radiographic evaluation for periprosthetic osteolysis revealed:

- Osteolysis was observed in 1 patient (3.3%) overall.
- The majority of patients (96.7%) did not exhibit any signs of osteolysis at any follow-up interval.

This outcome is detailed in [Table 4].

Complications

The overall complication rate was low:

- One case of infection and one case of death were reported (each 3.3%), with no cases of cement spillage observed.
- The remaining 93.3% of patients had no reported complications.

See [Table 5] for a summary of complications.

Table 1: Demographic Characteristics and Injury Details.

Variable	Frequency	Percent (%)
Sex		
Male	17	56.7
Female	13	43.3
Mode of Injury		
Fall on ground	17	56.7
Fall from bike	3	10.0
Fall from stairs	9	30.0
Fall from height	1	3.3
Side of Fracture		
Right	19	63.3
Left	11	36.7

Table 2: Saline Lavage Used

Saline Used	Frequency	Percent (%)
Cooled Saline (2°C – 8°C)	14	46.7
Room Temperature Saline (25°C – 27°C)	16	53.3
Total	30	100

Table 3: Comparison of Intraoperative Hemodynamic Parameters (Mean ± SD)

Parameter	Group A: Cooled Saline	Group B: Room Temp Saline	P-value
Before Cementing			
Body Temperature (°F)	96.34 ± 0.41	96.55 ± 0.38	0.014
Systolic BP (mmHg)	122.50 ± 2.90	122.81 ± 4.30	0.001
Diastolic BP (mmHg)	76.42 ± 3.03	78.25 ± 2.97	0.001

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Pulse Rate (bpm)	87.71 ± 8.00	88.87 ± 8.32	0.001
SpO_2 (%)	98.78 ± 0.42	98.56 ± 0.51	0.001
After Cementing (12 min)			
Body Temperature (°F)	97.30 ± 0.54	97.01 ± 0.58	0.001
Systolic BP (mmHg)	112.71 ± 3.51	94.37 ± 8.34	0.001
Diastolic BP (mmHg)	70.14 ± 2.24	68.25 ± 2.97	0.001
Pulse Rate (bpm)	79.21 ± 7.72	72.81 ± 7.73	0.001
SpO_2 (%)	97.21 ± 0.57	93.93 ± 0.25	0.001

Table 4: Incidence of Periprosthetic Osteolysis on 1-Year Follow-up

Osteolysis	**Frequency**	**Percent (%)**
Present	1(Room Temp. Saline used)	3.3
Absent	29	96.7
Total	30	100

Table 5: Overall Complication Rates

Complication	**Frequency**	**Percent (%)**
Death	1(Room Temp. Saline used)	3.3
Infection	1(Room Temp. Saline used)	3.3
Cement Spillage	0	0
No Complication	28	93.3
Total	30	100

DISCUSSION

This study evaluated the impact of saline temperature during cementing on intraoperative hemodynamic parameters and the long-term incidence of periprosthetic osteolysis in partial hip replacement in Central India. Our findings demonstrate that cooled saline lavage results in a more controlled cementing process, as evidenced by a significantly smaller drop in systolic blood pressure, pulse rate, and oxygen saturation post-cementing compared with room temperature saline lavage. This suggests that reducing the temperature of the saline lavage may mitigate the exothermic reaction of PMMA polymerization and decrease thermal injury to the bone.

Our results are consistent with early work by Charnley and McKee that highlighted the detrimental effects of high cement temperatures on bone integrity.[1,2] Subsequent studies by Willert et al,[3] and Jasty et al,[4] established a link between thermal injury and the development of periprosthetic osteolysis. More recent investigations by Toksvig-Larsen and Ryd,[5] and Lai et al,[6] have explored cooling techniques to improve cement handling. Our study extends these findings by demonstrating that cooled saline not only stabilizes intraoperative hemodynamics but also correlates with a low incidence of osteolysis (3.3%) at one year.

Furthermore, literature by Vaishya et al,[7] and Noordin et al,[8] emphasizes the importance of modifying cementing techniques to reduce the risk of implant failure. Our observed low complication rates, in conjunction with stable vital parameters, support the hypothesis that cooled saline lavage can decrease the thermal stress on bone tissue and reduce the biological cascade leading to osteolysis. Additionally, studies by Harris et al,[9] and Barrack et al,[10] have reported that improved cementing protocols lead to better long-term outcomes, which our results further corroborate.

In comparison to other series, our study from Central India provides evidence that even in resource-constrained settings, simple modifications such as using cooled saline lavage can yield significant clinical benefits. While our sample size is modest, the statistically significant differences in hemodynamic parameters and the favorable radiological outcomes warrant further investigation in larger multicenter trials.

Recommendation: Early adoption of cooled saline lavage during cementing in partial hip replacement may reduce thermal injury and the subsequent risk of periprosthetic osteolysis.

CONCLUSION

The present study demonstrates that cooled saline lavage during cementing in partial hip replacement leads to improved intraoperative hemodynamic stability and a lower incidence of periprosthetic osteolysis. These results support the potential benefits of this technique in reducing thermal injury and improving long-term implant fixation. Further research with larger cohorts is recommended to confirm these findings.

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