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Culture and Sensitivity Test for Fluid of Hemovac after Hip and Knee Arthroplasty

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ABSTRACT
Background: From the standpoint of the case, periprosthetic joint infection (PJI) is a serious side effect of primary total hip and knee replacement. It is also expensive for healthcare systems. Following hip and knee replacements, closed suction drainage (CSD) has become a common surgical procedure. To search for and validate PJI, a number of laboratory criteria have been employed. For many bacterial and fungal infections, the gold standard for diagnosis is still a culture and sensitivity test (C/S). **Objectives:** to determine the sensitivity and predictive utility of culture testing for Hemovac fluid following hip and knee replacements.

Patients and Methods: Eighty-two cases undergoing primary hip and knee arthroplasty participated in this research. Every case underwent a thorough history, clinical, and laboratory evaluation. Within 48 hours of operation, two samples were taken concurrently from the Hemovac drainage fluid, and they were analyzed using the following methods: glucose level, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), white blood cell count (WBC), differential leukocytic count, and culture and sensitivity test. Two samples were taken at 7–10 days and 14–21 days for the culture and sensitivity Test.

Results: The incidence of positive C/S results from Hemovac drain fluid following hip and knee replacements was very low, so routine C/S testing in cases who are asymptomatic has minimal predictive value for postoperative infections.

Conclusion: After hip and knee replacements, this research showed a very low rate of positive culture in Hemovac drain fluid, which has little clinical significance in anticipating early postoperative infection.

Keywords: Periprosthetic joint infection, Total hip and total knee arthroplasties, Hemovac drains, Culture and sensitivity test.

INTRODUCTION

Total hip and knee arthroplasty (THA, TKA) can significantly enhance mobility, function, and quality of life for patients with severe arthritis [(1)].

Following initial total hip and TKA, PJI is an uncommon but disastrous complication that can result in serious case morbidity and high expenses for the healthcare system. The 1-year and 5-year risks of PJI for THA and TKA were 0.69% and 1.09%, respectively, based on the Medicare incase dataset [(2)].

Many organizations and cohorts have defined PJI in different ways over the years. The defining criteria for the diagnosis of PJI were put forth at the International Consensus Meetings in 2014 and 2018. As a result, new working standards are presently being revised after being introduced at the EBJIS 2018 annual meeting in Helsinki, Finland. The diagnostic criteria were created by the Musculoskeletal Infection Society following an assessment of the available data. When one of the following conditions is satisfied, a PJI is considered final.

The prosthesis is connected to a sinus tract; a pathogen is isolated by culture from two or more distinct tissue or fluid samples taken from the afflicted prosthetic joint; or at least four of the six requirements listed below are met: increased synovial white blood cell count, increased synovial polymorph nuclear percentage (PMN%), increased serum erythrocyte sedimentation rate and serum CRP concentration, purulence in the affected joint, insulation of a microorganism in one culture of periprosthetic tissue or fluid, or more than five neutrophils per high-power field in five high-power fields as determined by histologic analysis of periprosthetic tissue at ×400 magnification. If less than four of these conditions are satisfied, there may be a PJI [(3)].

The primary cause of revision TKA and one of the top two reasons of THA revision operations is PJI [(4)]. Recent research evaluating the current causes of revision surgery following THA found that acute PJI accounted for 26% of revision surgeries including the exchange of at least one modular implant, while wound-related complications accounted for 49% of revision procedures [(5)].

Obesity, rheumatoid arthritis, urinary tract infections, blood transfusions, diabetes mellitus, prolonged surgical time, and numerous simultaneous joint implantations are some risk factors for PJI that have been identified. Large hematomas, prolonged or severe wound secretion, and delayed wound healing all raise the risk of PJI in the early postoperative phase [(6)].

The pathogenesis (exogenous versus hematogenous), joint type, and infection duration all affect how PJI manifests clinically. Acute exogenous PJI is characterized by localized inflammation, including skin erythema, fever, disruption of wound healing, fluid draining via the open site, and purulent discharge. High-grade fever is more of an anomaly [(7,8)].

Since Hippocrates' time, or CSD, has been a common surgical technique. Rather than relying on scientific data, many surgeons adhere to the practice because of their early training. Proponents contend that postoperative CSD prevents hematoma development and lessens ecchymosis, both of which worsen wound healing by raising wound tension and lowering blood circulation to surrounding tissue. Furthermore, bacterial

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colonization from a hematoma can result in both superficial and deep-seated infections [9].

Nearly every type of microorganism has been identified in PJI, including Legionella, Mycobacterium tuberculosis, nontuberculous mycobacteria, Mycoplasma, and fungal agents. In various joints, the organisms' relative frequencies vary. However, Staphylococci prevail in all forms of PJI [10].

To search for and validate PJI, a number of laboratory criteria have been employed. Some of them are only useful as justifications for PJI and are not sensitive enough. The most crucial diagnostic procedures for cases with suspected PJI are leukocyte and differential counts in synovial fluid [11,12].

Because of their low sensitivity, swab cultures ought to be avoided. Synovial fluid culture has a minimum 95% specificity and a sensitivity of roughly 85%. Using PCR or culturing synovial fluid in blood culture flasks improves sensitivity [13].

"Is there any predictive value to do a culture and sensitivity test for fluid of Hemovac within 48 hours after Hip and Knee Arthroplasty?" is the final topic this research aims to address.

PATIENTS AND METHODS

Patients:

82 cases who had primary hip and knee replacements at Menoufia University Hospital between 2020 and 2025 were included in this research; Hemovac drains were used in every case. Forty-five cases with osteoarthritis in their knees got complete knee replacement, and 37 cases with osteoarthritis in their hips underwent total hip replacement.

Inclusion criteria:

- Every case having primary knee and hip replacement surgery.
- Be at least 40 years old.
- A body mass index below 35 kg/m².

Exclusion criteria:

- A mental illness that might affect treatment outcomes or follow-up.
- Cases of revision.

Methods:

Every individual was exposed to:

- **History:** Individual information, including name, gender, age, occupation, past medical history, and current symptom history.
- **Local examination and body mass index** are included in the clinical evaluation. a) Skin: Injuries, scars, redness, bruises, tenderness, and sinuses**.** b) Vascular and neurological evaluation of both lower limbs.
- **Radiological evaluation:** Before and after surgery, plain X-rays of the knee and hip were obtained.
- **Preoperative assessment and management:** To reduce the risk of nosocomial infections, hospitalization before to surgery was minimized.

  A comprehensive blood picture, urine analysis, liver and kidney function tests, electrocardiogram, random blood sugar, bleeding tendency, erythrocyte sedimentation rate, and C-reactive protein were all performed prior to the procedure.

  Cases with distant illnesses, such as urinary tract and dental infections, received treatment first until the infection totally went away.
- **Operative:**
  - **I. Anesthesia:** The following criteria were taken into consideration while choosing an anesthetic technique: Associated medications and medical conditions, surgery duration and related complications, and anesthetist and surgeon preferences
  - **II. Sterilization:** There were as few people as possible in the operation room. As little traffic as possible entered and exited the theater. In every instance, double sterilization and draping were done on a regular basis.
  - **III. Antibiotics:** All cases received prophylactic antibiotics (third-generation cephalosporins) half an hour prior to surgery.
  - **IV. Operative procedures:** Forty-five cases with osteoarthritis in their knees got total knee replacement, and 37 cases with osteoarthritis in their hips underwent primary total hip replacement. Using the best surgical technique possible, handling tissues with care, and positioning components correctly were all part of the operation's surgical procedure. Additionally, to reduce the risk of contamination from continuous saline washing, the surgical incision was frequently washed with plastic pulsed lavage, which was only used once. Carefully closing the arthrotomy was followed by the subcutaneous layer and skin closure using staples. Before the arthrotomy was closed, a negative suction drain was used. A few centimeters away from the first incision, a separate opening was used to implant the drain. The tube was attached to a sharp trocar that was part of the drain. In a nondependent location, the trocar was used to pierce the skin within and emerge via the proximal end of the stab incision. A stay-stitch was used to secure the drain to the skin. Typically, the suction drainage was eliminated 48 hours following the procedure.
- **Postoperative data:** Medication after surgery: Analgesia such as 50 mg of pethidine three times a day for two days, followed by non-steroidal anti-inflammatory drugs twice a day for five days, and then oral medication if necessary. Third-generation cephalosporin antibiotics, administered parenterally for two days and orally for five days in instances that are not complex. For 14 days, each case got a subcutaneous injection of a 40 mg prefilled enoxaparin syringe once daily. The

stitches were taken out after the first two weeks of monitoring the wound condition. During the first four to five weeks following surgery, partial weight bearing with axillary crutches was permitted; after six to ten weeks, complete weight bearing with elbow crutches on the contralateral side was permitted. Within 48 hours following surgery, two samples were taken concurrently from the Hemovac drainage fluid. These samples were then subjected to culture and sensitivity tests, as well as analyses for glucose levels, WBC, differential leukocytic counts, CRP, and ESR. After surgery, the sensitivity and culture samples were collected 7–10 days and 14–21 days later.

Ethics approval:

All participants gave their informed consent after being briefed on the purpose, methodology, and relevant goals of the research. Both the service offered, and the research process had no negative effects on the participants. The study was approved by the Institutional Review Board and the Medical Faculty's Ethics Committee of Menoufia University . The study adhered to the Helsinki Declaration throughout its execution.

Statistical Analysis

IBM SPSS software version 20.0 (Armonk, NY: IBM Corp.) was used to enter and analyze the data. Counts and percentages were used to summarize the qualitative data. Mean and standard deviation were used to characterize quantitative data. Univariable logistic regression was used to analyze important clinical factors which might be associated with positive culture. At the 5% level, the results were deemed statistically significant.

RESULTS

According to table 1, the average age was 64.96±7.3 years, with 57.3% of the population being females and 42.7% being males. BMI showed that 56.1% were 25-30 kg/m^2.

Table (1): Distribution of studied cases according to demographic data.

Variables	N (82)	
Age (years)		
Mean ± SD	64.96±7.3	
Gender	**N**	**%**
Male	35	42.7%
Female	47	57.3%
BMI (kg/m^2)	**N**	**%**
18.5-24.9	12	14.6%
25-30	46	56.1%
30-35	24	29.3%

SD: standard deviation, **BMI:** body mass index.

51.2% had hypertension and 29.3% were smokers, **according to table 2**.

Table (2): Distribution of studied cases according to Co-morbidities data (N=82).

Co-morbidities	N	%
DM	32	39.0%
HTN	42	51.2%
Smoker	24	29.3%
Cardiac	15	18.3%
Rheumatoid arthritis	1	1.2%

DM: diabetes mellitus, **HTN:** hypertension.

According to table 3, 54.9% of cases had knee OA and underwent total knee arthroplasty.

Table (3): Distribution of studied cases according to diagnosis data

Variables	N (82)	
Diagnosis	**N**	**%**
Hip OA	37	45.1%
Knee OA	45	54.9%
Procedure	**N**	**%**
THR	37	45.1%
TKR	45	54.9%

OA: osteoarthritis**, THR:** total hip replacement, **TKR:** total knee replacement.

Table 4 demonstrates that no one had a preoperative infection or blood transfusion, the average operating time was 2.3±0.6 hours.

Table (4): Distribution of studied cases according to operation data

Variables	N (82)	
Preoperative infection	**N**	**%**
Yes	0	0.0%
No	82	100.0%
Time of operation (hours)		
Mean ± SD	2.3±0.6	
Blood Transfusion	**N**	**%**
Yes	0	0.0%
No	82	100.0%

SD: standard deviation

Table 5 demonstrates that the drain operated 100% of the time. 90.2% of the drain was greater than 500 cm.

Table (5): Distribution of studied cases according to drain data

Variables	N (82)	
Drain	**N**	**%**
Working	82	100.0%
Not working	0	0.0%
Amount of drain	**N**	**%**
<500 cm	8	9.8%
>500 cm	74	90.2%

According to table 6, the average RBS was 95.93±13.59, the average WBC was 7974.4±1508.9, the average ESR (1st H) was 16.61±9.475, and 26.8% of cases had a positive CRP.

Table (6): Distribution of studied cases according to laboratory data

Variables	N (82)	
RBS (mg/dL)		
Mean ± SD	95.93± 13.59	
WBC (cells/mm^3)		
Mean ± SD	7974.4±1508.9	
ESR (1st H) (mm/hr)		
Mean ± SD	16.61±3.475	
ESR (2nd H) (mm/hr)		
Mean ± SD	33.96±12.19	
CRP (mg/L)	**N**	**%**
Positive	22	26.8%
Negative	60	73.2%

RBS: random blood sugar**, WBC:** white blood cell count, **ESR:** erythrocyte sedimentation rate, **CRP:** c - reactive protein, **SD:** standard deviation.

According to table 7, 2.4% of cases had positive C/S results.

Table (7): Distribution of studied cases according to culture and sensitivity

C/S	N (82)	
Simple	**N**	**%**
Positive	2	2.4%
Negative	80	97.6%
Extended	**N**	**%**
Positive	2	2.4%
Negative	80	97.6%

C/S: Culture and Sensitivity Test, **N:** Normal

A statistically significant positive connection was found between positive culture, age, BMI, RBS, WBC, ESR, and CRP **(Table 8).** However, there was no discernible relationship between the volume of drain and the favorable culture.

Table (8): Correlation between positive culture and different variables

Variables	r	P-value
Age	**0.94**	**0.01***
BMI	**0.42**	**0.02***
RBS	**0.49**	**0.001***
WBC	**0.305**	**0.012***
ESR	**0.313**	**0.009***
CRP	**0.329**	**0.006***
Drain amount	0. 573	0.17

BMI: body mass index, **RBS:** random blood sugar**, WBC:** white blood cell count, **ESR:** erythrocyte sedimentation rate, **CRP:** c - reactive protein.

First, we examined significant clinical characteristics that could be linked to positive culture using univariable logistic regression **(Table 9).** We discovered that positive culture was linked to elderly people with high RBS, WBCs, CRP, and ESR. Next, we adjusted for confounding variables using multivariable logistic regression. We discovered that positive culture was still linked to older people and those with high WBCs, CRP, and ESR.

Table (9): Factors associated with positive culture

	Univariable models		**Multivariable model**	
	OR (95% CI)	***P*-value**	**OR (95% CI)**	***P*-value**
Age (years)	1.78 (0.89–1.49)	<0.01*	1.05 (1.01–1.09)	<0.01*
BMI	1.01 (0.71–1.22)	0.45		
RBS	2.07 (1.15–3.72)	0.02*	1.52 (1.10–2.21)	0.14
WBC	3.17 (1.57–4.21)	0.03*	2.47 (1.89–3.41)	0.04*
ESR	2.42 (1.52–3.14)	<0.01*	1.89 (1.14–2.11)	<0.01*
CRP	1.98 (0.89–1.49)	<0.01*	1.05 (1.01–1.09)	<0.01*
Drain amount	1.52 (0.91–1.66)	0.25		

BMI: body mass index, **RBS:** random blood sugar**, WBC:** white blood cell count, **ESR:** erythrocyte sedimentation rate, **CRP:** c - reactive protein.

DISCUSSION

One of the most popular orthopedic procedures done globally is total hip and knee arthroplasty, which significantly improves mobility and quality of life. Even though they are uncommon, postoperative infections can nonetheless seriously harm surgical results [14,15]. The prognostic usefulness of routine culture and sensitivity (C/S) testing of drain fluid is still unknown, despite the fact that Hemovac drains are frequently utilized to monitor postoperative fluid [16]. Our goal was to determine if C/S of Hemovac fluid could be a good indicator of early post-operative infection after knee and hip replacements.

Only 2.4% of the 82 cases in this research who had either total hip or knee arthroplasty had positive Hemovac fluid cultures, and the rate of postoperative complications like fever, hyperemia, and wound leaking was likewise low. Prior to surgery, every case was sterile, and none of them needed intraoperative blood transfusions. Although the majority of cases had substantial drainage outputs (>500 ml), there was no discernible correlation between infection and drain quantity. In univariate analysis, positive culture results were substantially associated with older age, higher BMI, higher RBS, and inflammatory markers like WBC, ESR, and CRP; However, only age, WBC, ESR, and CRP were validated as independent predictors by multivariable models. According to these results, routine C/S testing of Hemovac fluid in cases who are asymptomatic may not be required in the absence of clinical signs and has minimal predictive value for postoperative infections.

According to this research, just two out of 82 cases had positive culture and sensitivity (C/S) results from Hemovac drain fluid following hip and knee replacements. This is a very low incidence. This is consistent with research by **Sangaletti *et al.*** [17] that highlighted the need for more trustworthy markers by finding that the culture of drain fluid showed low sensitivity and limited predictive value for PJIs.

This research showed a substantial correlation between good culture findings and specific case characteristics. Age, BMI, ESR, WBC, RBS, and CRP were among them. Significantly, there was a considerable positive association between age and C/S outcomes (r=0.94, p=0.01), indicating that older cases may be more susceptible to favorable results. This result is in line with research by **Areti *et al.*** [18], which found that immunosenescence and concomitant diseases make older people more vulnerable to postoperative infections.

Age, WBC, ESR, and CRP were found to be substantially linked with positive culture findings in both univariate and multivariable logistic regression models. In the multivariable model, WBC and ESR specifically maintained their significance, with WBC displaying an odds ratio of 2.47 (p=0.04) and ESR at 1.89 (p<0.01). These results demonstrate how useful systemic inflammatory indicators may be in anticipating surgical site infections. In support of this, **Klemt *et al.*** [19] highlighted the combined diagnostic value of WBC, ESR, and CRP for PJI early diagnosis.

Contrary to some other findings, this research also found that the drain quantity was not significantly associated with positive cultures (p=0.17). **Porrino *et al.*** [20] **and Campbell** [21], for instance, found that higher drain output might be associated with early infections, most likely because of increased hematoma development that serves as a medium for bacterial growth. Our findings, however, imply that drain volume by itself might not be a trustworthy predictor of infection risk, particularly when low culture positive is present.

The limited ability of standard extended culture techniques to increase diagnostic yield is further highlighted by this research. The low positive rate found in standard cultures was also found in extended cultures. According to **Langvatn** [22]**, Al-Jabri *et al.*** [23]**, and Saeed** [24]**,** extended cultures can help identify low-virulence organisms, but their clinical significance is still unknown unless they are directed by a strong preoperative suspicion or confirming clinical indications.

With only 2.4% of cases testing positive, this research demonstrated an exceptionally low incidence of positive C/S results from Hemovac drain fluid following hip and knee arthroplasty. This supports earlier findings that routine drain fluid culture is not very useful for diagnosing PJIs. According to **Pietrzak** [25] **and Lucenti *et al.*** [26]**,** routine postoperative cultures are not always cost-effective because positive drain cultures are rare and frequently do not correspond with clinical infection.

Clinical postoperative consequences were found to be limited in this research, with only 2.4% of cases having fever, hyperemia, or wound leaking. The idea that arthroplasty is generally safe when carried out in accordance with established protocols that include infection prevention measures is supported by these low incidences of problems. Our lower complication rate may be the result of a well-controlled surgical environment and proper perioperative care, as previous studies by **Cunningham *et al.*** [27] **and Matar *et al.*** [28] reported slightly higher rates of early postoperative complications, particularly in high-risk or comorbid populations.

Despite the fact that 90.2% of cases had a drain output greater than 500 cm³, this was not statistically linked to culture positive (p=0.17), according to this research. In contrast, research by **Pathak *et al.*** [29] **and Almeida *et al.*** [30] found a correlation between higher drain output and a higher risk of infection because of the possibility of hematoma formation.

The results, however, are consistent with more recent research that suggests the amount of drainage by itself might not be a good indicator of infection and shouldn't be used to inform clinical judgments in the absence of other indications of inflammation or systemic infection.

In addition to evaluating laboratory measures, this research discovered a mean WBC of 7974.4/mm³, an ESR of 16.61 mm/hr at the first hour, and a CRP positive rate of 26.8%. Remarkably, multivariable analysis revealed that positive C/S findings were independently correlated with WBC, ESR, and CRP. **Tripathi *et al.*** [31] highlighted the diagnostic utility of these inflammatory markers in identifying early PJIs, and these findings are consistent with their findings. However, when combined, these indicators continued to be powerful predictors in our analysis, confirming their use in postoperative surveillance.

Age and cultural positivity were found to be statistically significantly correlated in this research, with a very strong positive correlation (r=0.94, p=0.01). Age continued to be a significant factor in multivariable analysis (OR=1.05, p<0.01). This is in line with research by **Gonçalves *et al.*** [32]**,** which showed that older cases have a higher risk of infection because of a weakened immune system and a higher burden of comorbidities.

The results further highlight how crucial careful postoperative monitoring is for older cases having arthroplasty.

This research discovered that postoperative problems were minor and culture positive remained low even though drains were used in every case. This lends credence to the ongoing discussion regarding the use and necessity of surgical drains in arthroplasty. Some research supports the use of drains to avoid the formation of hematomas and seromas, while other research supports their usage to lower the risk of infection. The findings imply that, when used properly, drains may not always raise the risk of infection, especially in surgical settings that are well-optimized.

All cases in this trial did not require intraoperative blood transfusions, nor were there any instances of preoperative infection. These results demonstrate superior intraoperative hemostasis and preoperative optimization, both of which are essential for reducing postoperative problems. On the other hand, research by **Tanaka *et al.*** [(33)] has shown that intraoperative transfusion is linked to a higher risk of surgical site infections and longer hospital admissions. The extremely low rate of positive culture (2.4%) and the few postoperative problems seen were probably caused by our ability to prevent transfusion and maintain sterile settings.

A mean operating time of 2.3 ± 0.6 hours was recorded in this research, which is within the typical range for main hip and knee replacement surgeries. Longer operating times have been linked to an increased risk of infection in the past, especially when they surpass 2.5–3 hours [(34)]. According to the results, following effective operating procedures without sacrificing surgical quality is essential for lowering the risk of infection and improving postoperative results.

It is difficult to determine the true cost of treating an infected joint. For hospitals, healthcare systems, and—above all—cases, managing PJI poses a significant clinical and financial burden. Consequently, it is vitally necessary for cases, hospitals, and health care systems to diagnose prosthetic joint infections as soon as possible [(35)].

This research's thorough assessment of clinical, laboratory, and surgical factors in a specific case cohort undergoing hip and knee replacements is one of its main strengths. The validity of our findings is increased by the prospective nature of data collection and the inclusion of those individuals who were infection-free at baseline. Additionally, in order to find independent determinants of positive Hemovac fluid culture, we employed both univariate and multivariable statistical models. The research's shortcomings, such as its limited sample size and low rate of positive cultures, could restrict how far the findings can be applied. Furthermore, findings of delayed or chronic infections are limited by the lack of long-term follow-up data.

CONCLUSION

After hip and knee replacements, this research showed a very low rate of positive culture in Hemovac drain fluid, which has little clinical significance in anticipating early postoperative infection. The only factors that significantly correlated with positive cultures were age, WBC, ESR, and CRP. These results imply that it would not be necessary to perform routine drain fluid culture and sensitivity testing on asymptomatic individuals. Alternatively, focused testing according to laboratory and clinical markers might work better. To confirm these findings, more research with bigger sample sizes and longer follow-up is advised.

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