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TREATMENT OF CHRONIC OSTEOMYELITIS BY MASQUELET TECHNIQUE

By

Ibrahem Abu El-Enine Ezz El-Dine Ahmed, Mohamed Abd El-Rahman Bessar and Amr Ahmed Fouad

Department of Orthopedics, Faculty of Medicine, Al-Azhar University

***Corresponding Author:** Ibrahem Abu El-Enine Ezz El-Dine Ahmed,

E-mail: ibrahemsharpasy@yahoo.com

ABSTRACT

Background: Osteomyelitis is a major problem in orthopedic surgery and is usually associated with open fracture surgery, bone reconstruction surgery, or orthopedic implants. Antibiotics alone cannot eradicate chronic osteomyelitis, surgical debridement and sequestrectomy is required to debride all necrotic and infected bone, soft tissue and sinuses. The treatment of broad bone gaps is still a surgical challenge, and there is no consensus about the best reconstruction methods.

Objective: To evaluate the results of Masqulete technique in treatment of chronic osteomyelitis.

Patients and Methods: This was a prospective study that was conducted on 10 patients with chronic osteomyelitis done at Al-Azhar University and El Minia Health Insurance Hospitals during the period between May 2019 and May 2020. All patients were subjected to Masquelet Procedure, bone ends were debride until bleeding. The bone temporarily stabilized by external fixator, plate or intramedullary nail. The cement spacer was implanted with an overlap to the bone ends to provide a more extensive introduction of the membrane. After several weeks, the resultant then fibrous membrane was incised and the cement spacer removed. The contained void was filled with cancellous autograft. Autograft was obtained from iliac crest.

In the Masquelet Procedure, bone ends were debride until bleeding. The bone temporarily stabilized by external fixator, plate or intramedullary nail. The cement spacer was implanted with an overlap to the bone ends to provide a more extensive introduction of the membrane. After several weeks,the resultant then fibrous membrane was incised and the cement spacer removed. The contained void was filled with cancellous autograft. Autograft was obtained from iliac crest.

Results: This study comprised 6 men and 4 women. The average age of the included patients was 44.00 ± 2.62, and the average BMI was 25.20 ± 2.70. Among them 4 (40 %) patients did exercise, 3 (30 %) patients had smoking history, and 3 (30 %) patients had hypertension history. The study showed that post Masque let Technique complications are: 60% of patients had no complications, 20% had partial necrosis at edge of the flap, and 20% had superficial infection around the incision.

Conclusion: Masquelet technique was a good new challenge in reconstruction treatment of chronic osteomyelitis with simple surgical procedure and low incidence of postoperative complications.

Keywords: Chronic Osteomyelitis, Masquelet Technique.

INTRODUCTION

Osteomyelitis is an infection of bone or bone marrow with a concomitant inflammation involving the bone marrow and the surrounding tissues. These infections can originate from many different mechanisms. The common cause of osteomyelitis is a bacterial infection with Staphylococcus aureus after surgical intervention. Osteomyelitis is a major

complication in orthopedic surgery and is usually associated with open fracture surgery, bone reconstruction surgery, or orthopedic implants. Despite the numerous cases of osteomyelitis in orthopaedic surgery, there is no precise epidemiological data available *(Inzana et al., 2016)*.

A sequestrum derives from the destruction of bone tissue and bone matrix from inflammatory factors, including leucocytes and cytokines that increase the osteoclasts activity. Because of the lack of vascularization, and hence the impossibility to be reached by immunity cells and drugs, the sequestrum is the cause of persistent infection, since the pathogens are embedded in it. Several bacteria and fungi are common infecting microorganism. Staphylococcus aureus and Staphylococcus epidermidis are the most common pathogens *(Ramsden et al., 2017)*.

The goal of surgery is to achieve a viable vascularized environment free of dead bone. Antibiotics alone cannot eradicate chronic osteomyelitis; surgical debridement and sequestrectomy is required to debride all necrotic and infected bone, soft tissue and sinuses *(Yeh et al., 2020)*.

After debridement of the infected site, there is an area left that is termed dead space. Dead space management typically involves harvesting autologous or autogenousbone grafts, most often from the pelvic iliac crest, followed by implantation into the defect site. Autologous bone grafts remain the gold standard for promoting healing, with almost 2.2 million procedures estimated per annum *(Palestro, 2015)*. However, the use of autologous bone grafts is limited by considerable donor site morbidity, postoperative pain, and risk of infection and the lack of available tissue. Allogeneic bone grafts can also be employed, most commonly by transplantation of sterilized cadaverous bone *(Calhoun et al., 2012)*.

The aim of the present study was to evaluate the results of Masqulete technique in treatment of chronic osteomyelitis.

PATIENTS AND METHODS

This was a prospective study that was conducted on 10 patients with chronic osteomyelitis at Al-Azhar University Hospitals and El Minia Health Insurance Hospitals during the period between May 2019 till May 2020.All patient were subjected to Masquelet Procedure, bone ends were debride until bleeding. The bone temporarily stabilized by external fixator, plate or intramedullary nail. The cement spacer was implanted with an overlap to the bone ends to provide a more extensive introduction of the membrane. After several weeks, the resultant then fibrous membrane was incised and the cement spacer removed. The contained void was filled with cancellous autograft. Autograft was obtained from iliac crest.

Inclusion Criteria: Any age, both sexes, all cases of symptoms of chronic osteomyelitis, good soft tissue condition, and long and short bones.

Exclusion criteria: Flat bones, bad soft tissue condition, and patient complaining of acute osteomyelitis.

Masquelet Technique was used in this study.

1. Preoperative preparations:

A. History taking including age, sex, BMI, smoking, exercise, hypertension, anatomic location & side involved.

B. Radiology:

- X ray: Anteroposterior (AP) and lateral views of the affected bone.
- CT angiography to evaluate arterial supply.
- CT scan to evaluate the extent and anatomy of the lesion.

2. Intraoperative measures (Figure 1):

Preoperatively, microbiological cultures were taken and preoperative standardized antibiotics with a second generation cefazolin were started.

Masquelet Procedure:

- It was done under general anesthesia and spinal anesthesia.
- In the first step, radical debridement was performed by debridement of all compromised tissue, proviosion of healthy vascularized tissue, elimination of dead space and implantation of antibiotics, and bone cement was performed.
- Taking three biopsies from compromised tissue that underwent culture and sensitivity to administer good systemic antibiotic coverage to eliminate the infection.
- Debridement was performed to expose normal cortical bone interface that known by fresh blood seen on edges.
- Bone defect was fixed using intramedullary nails or plates and screws. Vancomycin or vibramycin and PMMA bone cement were mixed at a ratio of 1:20, and put into bone defect to connect both ends, then the incision was closed **(Figure 1)**.

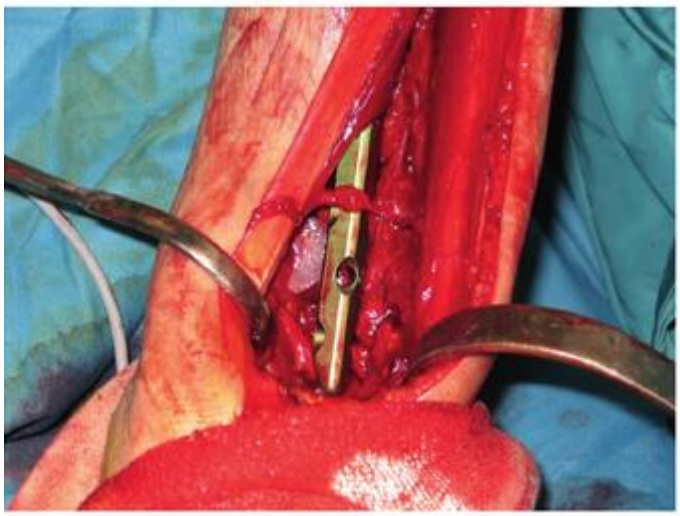

Figure (1): Intramedullary nail positioning after a wide curettage and infected bone removal in a distal tibia osteomyelitis.

Bone defect was reconstructed by cancellous bone grafting inaddition to fixation by intramedullary nai or plate and screw. An incision was made to expose the induced membrane formed around the defect. Membrane was cut longitudinally and then bone cement was removed carefully **(Figure 2)**.

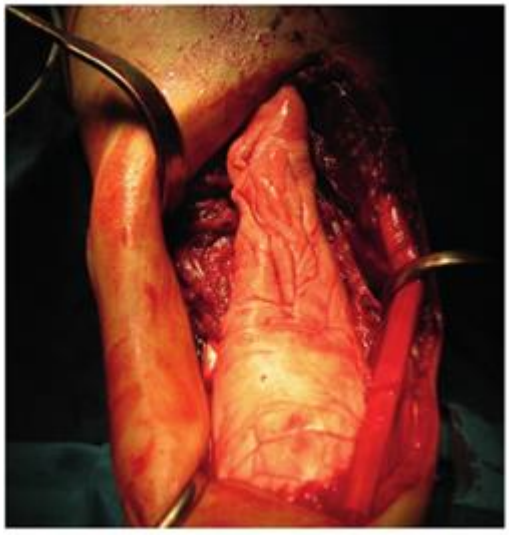

Figure (2): Cement spacer, shaped like the removed bone, fills the void.

The defect was filled with morselized cancellous bone graft. The incision was closed with regard good soft tissue coverage, washed with saline and disinfected with iodophor.

Follow Up:

- Mean follow up every two weeks.
- An X-ray in two planes was essential. The X-ray images were taken and examined under optimal conditions.

Laboratory diagnostics were CRP, ESR. IL-6, CBC.

- Consolidation occurred after 7-10 weeks.

Statistical Analysis:

Data were collected, revised, coded and entered to the Statistical Package for the Social Science (IBM SPSS) version 20. The qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges.

RESULTS

This study comprised 6 men and 4 women. The average age of the included patients was 44.00 ± 2.62, and the average BMI was 25.20 ± 2.70. Among them 4 (40%) patients did exercise, 3 (30%) patients had smoking history and 3 (30%) patients had hypertension history **(Table 1)**.

Table (1): Distribution of the studied cases according to age, sex, BMI, any exercise, smoking and hypertension

		No.= 10
Age	Mean ± SD	44.00 ± 2.62
	Range	40 – 48
Sex	Female	4 (40.0%)
	Male	6 (60.0%)
BMI (kg/m2)	Mean ± SD	25.20 ± 2.70
	Range	20 – 28
Smoking (%)	No	7 (70.0%)
	Yes	3 (30.0%)
Diabetes (%)	NO	6 (60%)
	Yes	4 (40%)
Hypertension (%)	No	7 (70.0%)
	Yes	3 (30.0%)

The cause of the preoperative infection was enterococcus faecalis in 2 (20%) patients, staphylococcus aureus in 5 (50%) patients, and staphylococcus epidermidis in 3 (30%) patients. The site of infection was in femur 3 (30%) patients, tibia 5 (50%) patients and toe 2 (20%) patients.
Specialist visits frequency was every three months in 4 (40%) patients, every half year in 3 (30%) patients, every year in 2 (20%) patients, and less than once a year in 1 (10%) patients.

SAS assessment in the current study, 4 (40%) patient suffered from mild anxiety, 5 (50%) patient suffered from moderate anxiety, and 1 (10%) patient suffered from severe anxiety.

The complications of induced membrane technique, 6 (60%) patients developed no complications, 2 (20%) patients developed partial necrosis at edge of the flap, and 2 (20%) patients superficial infection around the incision, and 1 (10%) patient developed postoperative infection **(Table 2)**.

Table (2): Distribution of the studied cases according to organisms, site of infection, specialist visits frequency, health assessment questionnaire assessment, activities of daily living assessment, standards aligned system assessment, 36-item short form survey (SF-36) assessment, complication type

		No.	%
Organisms	Enterococcus faecalis	2	20.0%
	Staph. Aureus	5	50.0%
	Staph. Epidermidis	3	30.0%
Site of infection	Femur	3	30.0%
	Tibia	5	50.0%
	Toe	2	20.0%
Health Assessment Questionnaire (HAQ) assessment	Score 0	1	10.0%
	Score 1	2	20.0%
	Score 2	4	40.0%
	Score 3	3	30.0%
Activities of daily living (ADLs) assessment	Function	3	30.0%
	Normal function	7	70.0%
Standards aligned system (SAS) assessment	Mild anxiety	4	40.0%
	Moderate anxiety	5	50.0%
	Severe anxiety	1	10.0%
36-item short form survey (SF-36) assessment	Normal	6	60.0%
	Probable depression	4	40.0%
Complication type	No complications	6	60.0%
	Non union	1	10.0%
	Fracture	0	0%
	Reinfection	2	20.0%
	Stiffness	1	10.0%

Regarding the limb examination in this study, the range of motion was not affected at all patients while the muscle power is only affected in 2 patients (20%) as shown in All the studied patients went through auto graft **(Table 3)**.

Table (3): Range of motion and muscle power and types of graft used in this technique in the studied groups

		No.	%
Limb examination	**Results of Examination**		
Range of motion	Affected	0	0 %
	Not affected	10	100%
Muscle power	Affected	2	20%
	Not affected	8	80%
Type of graft			
Auto-graft		10	100.0%
Allograft		0	0 %

Sixty percent 60% of patients developed no complications, 20% patients developed partial necrosis at edge of the flap, and 20% patients superficial infection around the incision, and 10% patient developed postoperative infection **(Table 4)**.

Primary bone healing was achieved in 80% of patients with an average healing time of 13.30 ± 2.50 weeks. Among them, 60% restored weight-bearing function after 19.70 ± 2.79 weeks **(Table 4)**.

Table (4): Distribution of the studied cases according to Primary bone healing, Restoration of weight-bearing function and Postoperative infection

Treatment outcomes		No.	%
Primary bone healing	No	2	20.0%
	Yes	8	80.0%
Restoration of weight? bearing function	No	4	40.0%
	Yes	6	60.0%
Postoperative infection	No	9	90.0%
	Yes	1	10.0%

The duration to union from the date of the second stage ranged from 2.5 to 8.5 months (a mean of 4.5 months) in both upper and lower extremity segmental defects **(Table 5)**.

Table (5): Distribution of the studied cases according to the time between first and second stage of the Masqulete technique, healing time (weeks), Time for restoration of weight-bearing function (weeks), pain scale (visual analogue scale) before and after Masquelet technique

		No. 10
Time between first and second stage (months)	Mean ± SD	7.4 ± 2.70
	Range	5-12
Healing time (weeks)	Mean ± SD	13.30 ± 2.50
	Range	10 – 17
Time for restoration of weight? bearing function (weeks)	Mean ± SD	19.70 ± 2.79
	Range	15 – 24
Pre-operative pair scale	Mean ± SD	6.3 ± 1.9
	Range	6-9
Post-operative pair scale	Mean ± SD	1.5 ± 1.3

DISCUSSION

This study comprised 6 men and 4 women. The average age of the included patients was 44.00 ± 2.62, and the average BMI was 25.20 ± 2.70. Among them 40% did exercise 30% had smoking history, and 30% had hypertension history.

Preoperative mean ESR, CRP, and WBC were 11.71 ± 1.61, 23.80 ± 3.79, 53.25 ± 3.48 respectively. In addition, PCT (ng/mL), TNF- α (pg/mL) and IL-6 (pg/mL) were 0.31 ± 0.05, 11.72 ± 3.47 and 11.36 ± 3.08 respectively. Similarly, *Sarah (2012)* showed that in subacute or chronic osteomyelitis, the ESR usually is mildly elevated (25 to 40 mm/hour), but can be normal. The sensitivity and specificity of CRP (cut-off value >14

mg/L) in diagnosis of osteomyelitis were 0.85 and 0.83. These values were 0.84 and 0.75 for ESR (cut-off value > 67 mm/h), 0.75 and 0.79 for WBC (cut-off value > 14 × 109/L), and 0.81 and 0.71 for PCT (cut-off value > 0.30 ng/mL), respectively, in study *(Michail et al., 2013)*.

Preoperative mean HbA1c (%), FBG (mmol/L), and HOMA-IR were 5.59 ± 0.50, 6.31 ± 0.66, 1.83 ± 0.28 respectively. In addition, LDL (mmol/L), Total cholesterol (mmol/L) and Triglyceride (mmol/L) were 2.13 ± 0.35, 4.83 ± 0.71 and 1.67 ± 0.28 respectively. These results are matched with those obtained by Wang et al. (2017) study which showed that all patients enrolled had laboratory studies concerning glucose and lipid metabolism. Patients in the DDM group had higher HbA1c, fasting blood glucose, fasting insulin (10.5 ± 2.4 μU/ml vs. 8.9 ± 2.1 μU/ml, $p < 0.001$) and calculated HOMA-IR than those in the control group.

In this study, the cause of the preoperative infection was enterococcus faecalis in 20% of patients, staphylococcus aureus in 50%, and staphylococcus epidermidis in 30%. The site of infection was in femur in 30% of patients, tibia in 50% and toe in 20%.

In addition, *Wang et al. (2017)* showed that Staphylococcus aureus accounted for 26.7% (4 strains) of bacteria strains. Conceding with the results obtained in this study, *Careri et al. (2019)* reported that staphylococcus aureus is responsible for 44% of cases, followed by staphylococcus epidermidis (17%), and streptococcus family (16%). The most common affected sites are forefoot, toes (43%) and lower extremities (20%). Like traumas and tumors, bone infections can cause extensive diaphyseal bone defects.

In this study, visits frequency was every three months in 40% of patients, every half year in 30%, every year in 20% patients, and less than once a year in 10%.

Regarding HAQ assessment of this study, 10% of patients was score 0, 20% were score 1, 40% were score 2, 30% were score 3. Similarly, most of patients experienced mild to moderate disability after the disease, as assessed by the health assessment questionnaire disability index (HAQ-DI) *(Irianto et al., 2019)*.

Regarding ADL assessment of the present study, 30% of patients had abnormal function, while 70% had normal function. These findings were matched with *Groll et al. (2018)* who concluded that concomitant septic arthritis may be the presenting diagnosis. It is an acute infection of the synovial membrane of the joints resulting in acute painful synovitis that can significantly limit activities of daily living. Regarding SF-36 assessment of this study, 60% of patients were normal, while 40% were probably depressed. In agreement with this study, *Hosseini et al. (2018)* concluded that the significant differences between the SF-36 results of the OM patients and the normal population in all eight dimensions indicate a poor quality of life for people who suffer from OM of the ankle-foot.

Regarding SAS assessment in the current study, 40% of patients suffered from mild anxiety, 50% suffered from moderate anxiety, and 10% suffered from severe anxiety.

Sixty percent 60% of patients developed no complications, 20% patients

developed partial necrosis at edge of the flap, and 20% patients superficial infection around the incision, and 10% patient developed postoperative infection.

In the work of *El Alfy and Ali (2015)*, there are 13 patients with an infected tibia, but no volume is being measured nor is the functional outcome reported. By contrast, the review shows that only in the papers from *Olesen et al. (2015)* and *Ley et al. (2019)* all patients had an additional infect. A recent study from *Gupta et al. (2016)* describes a prospective case series of the Masquelet technique in 9 tibia defects. Eight of these were infected. The same applies to *Ley et al. (2019)* in which all tibia defects had an infect but also no clinical outcome is being provided.

Moreover, *Ahmed et al. (2018)* reported that rates of septic complications leading to reconstruction failure range from zero to 8%; most of these failures are attributed to inadequate debridement.

However, *Taichi et al. (2020)* reported good clinical and radiological outcomes of treatment using the Masque let technique with iliac bone autograft for patients with septic arthritis in small joints of the hand. No complications such as non-union, recurrence of infection, or residual pain were observed.

In the present study, primary bone healing was achieved in 80% of patients with an average healing time of 13.30 ± 2.50 weeks. Among them, 60% restored weight-bearing function after 19.70 ± 2.79 weeks. These results are matched with those of *Ahmed et al. (2018)* study which concluded that union was achieved in 85% of patients. Nonunion occurred in three 15%. The duration to union from the date of the second stage ranged from 2.5 to 8.5 months (a mean of 4.5 months) in both upper and lower extremity segmental defects.

Similarly, *Mühlhäusser et al. (2017)* reported that full weight bearing was achieved after a median time of 16 (11-24) weeks. However, *Zeng et al. (2020)* reported that there was a high degree of variability in time to weight bearing.

CONCLUSION

Masquelet technique is a good new challenge in reconstruction treatment of chronic osteomyelitis with simple surgical procedure and low incidence of postoperative complications.

REFERENCES

1. **Ahmed M, Weam F, Mohamed M and El-sayed M. (2018):** Induced Membrane (Masquelet) Technique for Treatment of Long Bone Defects. Med J Cairo Univ., 86: 215-222.
2. **Calhoun JH, Manring MM and Shirtliff M (2012):** Osteomyelitis of the long bones. Seminars in Plastic Surgery, 23(2): 59-72.
3. **Careri S, Vitiello R, Oliva MS, Ziranu A, Maccauro G and Perisano C. (2019):** Masquelet technique and osteomyelitis: innovations and literature review. Eur Rev Med Pharmacol Sci., 23(2):210-216.
4. **El-Alfy BS and Ali AM. (2015):** Management of segmental skeletal defects by the induced membrane technique. Indian J Orthop., 49:643–8.
5. **Groll M, Woods T and Salcido R. (2018):** Osteomyelitis: A Context for Wound Management. Adv Skin Wound Care, 31(6):253-262.
6. **Gupta G, Ahmad S, Zahid M, Khan AH, Sherwani MKA and Khan AQ. (2016):** Management of traumatic tibial diaphyseal bone defect by "induced-membrane technique". Indian Journal of Orthopaedics, 50(3): 290-298.

7. **Hosseini M, Allami M and Soroush M. (2018):** Chronic traumatic ankle and foot osteomyelitis: a nationwide case-control study. Military Med Res., 5: 1-10.

8. **Inzana JA, Schwarz EM, Kates SL and Awad HA (2016):** Biomaterials approaches to treating implant-associated osteomyelitis. Biomaterials, 81: 58-71.

9. **Irianto K, Gema A and Sukmajaya W (2019):** Acute hematogenous osteomyelitis in children: a case series. Paediatrica Indonesiana, 59(4):222-228.

10. **Ley P, Gosselin RA and Villar R. (2019):** The Masquelet induced-membrane technique: an option for a tertiary-referral conflict setting. Journal of Surgical Case Reports, 19(6): 149-155.

11. **Michail M, Jude E, Liaskos C, Karamagiolis S, Makrilakis K and Dimitroulis D. (2013):** The performance of serum inflammatory markers for the diagnosis and follow-up of patients with osteomyelitis. The International Journal of Lower Extremity Wounds, 12(2):94–9.

12. **Mühlhäusser J, Winkler J, Babst R and Beeres FJ. (2017):** Infected tibia defect fractures treated with the Masquelet technique. Medicine, 96(20): 118-126.

13. **Olesen UK, Eckardt H, Bosemark P, Paulsen AW, Dahl B and Hede A. (2015):** The Masquelet technique of induced membrane for healing of bone defects. A review of 8 cases. Injury, 46: 44-47.

14. **Palestro CJ (2015):** Radionuclide imaging of osteomyelitis. In Seminars in nuclear medicine. Pbl. WB Saunders, 45(1): 32-46.

15. **Ramsden A, Chan J, Millar R and McNally M (2017):** Outcomes of free tissue transfer in treatment of chronic osteomyelitis. In orthopaedic proceedings. The British Editorial Society of Bone and Joint Surgery, 99(22): 3-13.

16. **Sarah SL. (2012):** Laboratory Manifestations of Infectious Diseases, Principles and Practice of Pediatric Infectious Diseases (Fourth Edition), Pbl. Elsevier, Pp. 1400-1412.

17. **Taichi S, Tomoyuki N, Hiroya K, Koji D, Satoshi N, Suguru Y, Minami M, Takenori U, Yasunori S, Masayuki K and Toshifumi O (2020):** The Masquelet technique for septic arthritis of the small joint in the hands: Case reports. Trauma Case, 25: 100268-100273.

18. **Wang X, Yu S, Sun D, Fu J, Wang S, Huang K and Xie Z. (2017):** Current data on extremities chronic osteomyelitis in southwest China: Epidemiology, microbiology and therapeutic consequences. Sci Rep., 7: 16251-16258.

19. **Yeh KJ, Husseini JS, Hemke R, Nelson SB and Chang CY (2020):** CT-guided discitis-osteomyelitis biopsies with negative microbiology: how many days should we wait before repeating the biopsy?. Skeletal Radiology, 49(4): 619-23.

20. **Zeng GJ, Foong WS, Xu S and Pang HN. (2020):** Induced Membrane Bone Grafting Technique for Treatment of Large Postinfectious Acetabular Bone Defects. Arthroplasty Today, 6(3): 322–329.

علاج التهاب العظام النيكروزى المزمن بتقنية ماسكوليت

إبراهيم ابو العنين عز الدين أحمد، محمد صلاح عبد الحفيظ، عمرو أحمد فؤاد

قسم جراحة العظام، كلية الطب، جامعة الأزهر

E-mail: ibrahemsharpasy@yahoo.com

خلفية البحث: التهاب العظم أحد المضاعفات الرئيسية في جراحة العظام وعادة ما يرتبط بجراحة الكسور المفتوحة أو جراحة إعادة بناء العظام أو زراعة العظام. ولا تستطيع المضادات الحيوية وحدها القضاء على التهاب العظم والنقي المزمن حيث يتطلب الأمر إجراء عملية إنضار وإستئصال جراحي لإزالة جميع العظام الميتة والمصابة بالعدوى والأنسجة الرخوة والجيوب الأنفية. ولا يزال علاج الفجوات العريضة يمثل تحديًا جراحيًا, ولا يوجد إجماع حول أفضل طرق إعادة البناء.

الهدف من البحث: تقييم تقنية ملء الفراغ العظمي في علاج إلتهاب العظام النيكروزي المزمن.

المرضى وطرق البحث: كانت هذة دراسة مستقبلية خضع لها 10 من مرضى الالتهاب العظمي النيكروزي المزمن بإستخدام تقنية ملء الفراغ العظمي وتمت المتابعة بعمل أشعة سينية في وضعين مختلفين, أجريت الدراسة في جامعة الأزهر ومستشفى المنيا للتأمين الصحي فى الفترة مابين مايو 2019 حتى مايو 2020. جميع المرضى خضعوا لأجراء عملية الماسكوليت حيث يتم إنضار النهايات العظمية و يتم تثبيت العظام بواسطة مثبت خارجي أو شريحة و مسامير أو مسار نخاعي مع وضع مبعد أسمنتي لملئ الفراغ العظمي و تغطية النهايات العظمية لتوفير مساحة أكبر لتغطية بالغشاء النسيجي. بعد عدة أسابيع يتم ازالة مبعد الأسمنت و يملأ الفراغ برقعة عظمية من عرف الحرقفة.

نتـــائج البحـــث: شـــملت هـــذه الدراســـة 6 رجـــال و 4 نســـاء. وكـــان متوســـط عمـــر المرضـــى المشـــمولين 44.00 ± 2.62، ومتوســـط مؤشـــر كتلـــة الجســـم 25.20 ± 2.70، مـــن بيـــنهم 4 (40٪) مرضـــى مارســـوا التمـــارين، 3 (30٪) مرضـــى لـــديهم تـــاريخ للتـــدخين وعـــلاوة علـــي 3 (30٪) مرضـــى لـــديهم تـــاريخ فـــي إرتفـــاع ضـــغط الـــدم. وقـــد أظهـــرت النتـــائج مـــا بعـــد تقنيـــة مـــلء الفـــراغ العظمـــي لعـــلاج إلتهـــاب العظـــام النيكـــروزي المـــزمن كـــالأتي: أن60% مـــن المرضـــى لـــيس لـــديهم أي مضـــاعفات، 20% مـــن المرضـــى لـــديهم نخـــز جزئـــي عنـــد حافـــة الســـديلة و علاوة علي 20% من المرضى لديهم إلتهاب سطحي حول منطقة الشق.

الاســـتنتاج: تعـــد تقنيـــة مـــلء الفـــراغ العظمـــي تحـــدياً جديـــداً وجيـــداً فـــي عـــلاج إعـــادة بناء العظام في إلتهاب العظام النيكروزي المزمن.

الكلمـــات الدالـــة: إلتهـــاب العظـــام النيكـــروزي المـــزمن، تقنيـــة مـــلء الفـــراغ العظمي.