Negative pressure therapy in the treatment of a traumatic fistula of glenohumeral joint with concurrent osteomyelitis and infection of periarticular tissues.

Bartosz Cybułka, Jacek Rapeła, Andrzej Wach

CASE REPORT

***Abstract*—A negative pressure dressing system enables effective dressing of traumatic wounds. Extensive injuries and tissue defects that accompany bone fractures and articular surface injuries require special management. In case of compound fractures, the risk of bone, joint and soft tissue infection significantly increases, so the appropriate healing process of traumatic wound is limited. Undisturbed healing process of traumatic wound is conditioned only by the proper wound dressing process by the removal of necrotic and ischemic tissues and elimination of the sources of infection. The article shows a case report of a patient with a traumatic subcapital humerus fracture complicated by a haematoma and then by a periarticular abscess. After the incision and drainage of a reservoir of blood and pus, a chronic infected fistula of glenohumeral joint was formed. During a prolonged therapeutic process an aggressive surgical management was implemented, by the removal of the infected bone, what eliminated the actively secreting fistula of glenohumeral joint. Following the appropriate wound preparation, the negative pressure therapy was successfully applied. In the described case the application of negative pressure dressing system enabled a gradual decrease of total wound depth and surface area and consequently, a restriction of tissue defects.**

***Keywords*—compound fracture, traumatic bone and joint injury, osteomyelitis, articular haematoma, articular abscess, joint fistula, NPWT**

I. Introduction

INFLAMMATION of the bones and bone marrow (osteomyelitis OM, OT post-traumatic osteomyelitis) is defined as an inflammatory process caused by the pyogenic organisms in bone tissues and leading to their destruction.[1] The Waldvogel classification, distinguishing blood-borne osteomyelitis, osteomyelitis spreading through continuity (associated or not associated with vascular diseases) and chronic osteomyelitis, has been used in clinical practice since 1970. Epidemiologically, in 80% of cases the disease process spreads through continuity. Only in 20% of the cases the aetiology is blood-borne.[2]

Manuscript received 12.02.2016; revised 28.06.2016. This work did not receive any financial support. Authors declare no conflict of interest.

Author affiliations: Department of Surgery and Gastroenterology, Independent Public Healthcare Institution, 62-065 Grodzisk Wielkopolski ul. Mossego 3, Poland, **(BC, JR, AW)**

*Correspondence to: Bartosz Cybułka (e-mail: b.cybulka@wp.pl).

Nowadays, lesions spreading through continuity are prevailing, mostly due to traumatic injuries as well as orthopaedic procedures involving implant materials. Such disease presentation mostly occurs in adults and is associated with blood supply deficits, which are very common in case of prosthetic joints implantation. A background of vascular disorders restricts normal healing process.[3]

The Cierny-Mader classifies OM according to anatomical location of lesions, patient's condition as well as general and local risk factors.[4] The following presentations of osteomyelitis are distinguished on the basis of anatomical range of pathology: medullary (type I) - restricted to bone marrow, of blood-borne aetiology; superficial osteomyelitis (type II); localised (type III) restricted to cortical bone layer, and diffuse (type IV) concerning all bone tissue layers. Among the local risk factors chronic lymphatic oedema, venous stasis, inflammatory vascular diseases, venous insufficiency, large surface scars, radiotherapy consequences, neuropathies, tobacco smoking are the most important. General systemic risk factors include malnutrition, chronic renal insufficiency, liver dysfunction, chronic hypoxia, diabetes, advanced age, young age, neoplastic disease, immunosuppression, and immunodeficiencies.[5]

Post–traumatic osteomyelitis is a rare medical condition. Exceptionally the infection of periarticular bone tissues is a result of a compound fracture. In case of long bone fractures, chronic inflammatory process occurs in less than 1-3% of traumatic patients.[6]

Treatment of chronic osteomyelitis is a prolonged, laborious and demanding process. Antibacterial treatment has limited value and systemic antibiotic therapy penetrates poorly to bone and bone marrow. Topical preparations applied as antiseptics (Octenisept [octenidine]) and lavaseptics (Prontosan [polyhexanide and betaine]) are not always able to eliminate the infection process, so new successful methods of therapy are still being searched for.

Recently, the following conditions were added to the classical contraindications for the application of negative pressure therapy:

- direct proximity of
  - vessels,

 DOI: 10.18487/npwtj.v3i2.21

Figure 1. RTG - subcapital displaced fracture of right humerus.

Figure 2. Surgical debridement.

  - nerves,
  - surgical anastomoses (vascular, of gastrointestinal tract)
  - parenchymal organs
- neoplastic process in the wound
- non-intestinal, non-diagnosed fistulas
- presence of necrotic tissue covered with scab in a wound
- haemostatic disturbances
- untreated osteomyelitis.[7, 8]

A rapid growth in the interest and application of negative pressure therapy in different domains significantly broadened the range of action of this modern method in wound treatment. Negative pressure therapy can be successfully used in previously non-indicated or even contraindicated clinical cases.

Apart from the classical application of negative pressure, effective attempts of using the systems enabling simultaneous wound washing (instillation NPWT - NPWTi) or hybrid therapies combining endoscopic and negative pressure techniques (endoVAC, EVT endoscopic vacuum therapy) are described more and more often.[9–12]

II. II Case Report

A 60-year-old male patient was admitted to the Department of Surgery due to the increase of pain in the right glenohumeral joint. Among the general symptoms, hectic fever was prevailing. Three weeks ago the patient fell down the stairs and

Figure 3. Negative pressure dressing.

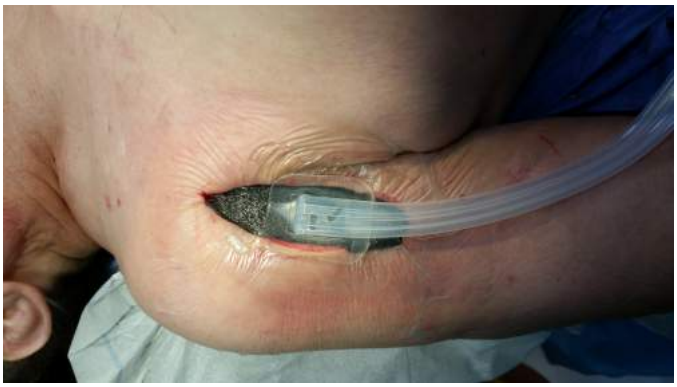

Figure 4. Negative pressure value - 120 mmHg.

Figure 5. Osteomyelitis.

Figure 6. Chronic fistula to the humeral bone.

Figure 7. Chronic joint fistula.

Figure 8. Destruction of the elements of the right glenohumeral joint. Open wound.

Figure 9. Stump of the humeral bone.

Figure 10. The secondary healing of the wound, formation of normal granulation tissue.

subcapital, displaced fracture of the right humerus occurred (Fig. 1). Conservative treatment of the fracture was applied by immobilisation in temporary shoulder joint orthosis.

On the physical examination: intense redness, increased skin warmth, pitting oedema of the skin of anterior shoulder area and the region of right glenohumeral joint were seen. Fluctuation and pathological crepitus in the periarticular tissues was palpable.

Laboratory examinations revealed leukocytosis and increased C-reactive protein values. LEU: $22.2\,\mathrm{K/\mu L}$; GRAN: $18.9\,\mathrm{K/\mu L}$; %GRAN: 85.4%. CRP32: 274.5 mg/L.

In the operating room, under topical anaesthesia, an incision was made and fluid was drained from the reservoir in the area of glenohumeral joint. Approximately 150 ml of purulent content and haemolysed blood was evacuated. A smear was collected for bacteriological examination which revealed a Methicilin-susceptible *Staphylococcus aureus* (MSSA). Gravity drainage was applied and empirical antibiotic therapy was implemented. At the beginning, drainage management and washing of the abscess cavity (Octenisept, 0.9% NaCl, H_2O_2) were continued. In the periods of increased leakage of bloody content, the wound was washed with 10% NaCl solution. The above described management enabled to limit the inflammatory process and normalise the laboratory indices of infection. What is important for the patient, also the pain was reduced.

During the treatment, persistent leakage of serous and purulent content from the wound was observed. As a result of prolonged leakage of pathological content, we decided to perform a surgical revision of abscess cavity and excised a fistula canal, leading to the level of medullary cavity, spongy bone layer of head of the humerus, under general anesthesia. Moreover, the ischaemic, necrotic tissues were removed, as well as the excessive inflammatory altered granulation tissue, and single reservoirs of purulent content were evacuated (Fig. 2). After refreshing the wound edges and wound bed, a negative pressure dressing was applied (Fig. 3 and 4) in continuous mode, at the negative pressure value of -120 mmHg (VivanoTec Hartmann). Total wound surface area and depth was adequate for using a M dressing (10 cm x 7.5 cm x 3.3 cm). Black polyurethane sponge was shaped to fit the wound, not allowing to excessively cramming the foam dressing. Prior to the application of negative pressure dressing, the wound bed was thoroughly washed with antiseptic solution (Octenisept). Healthy skin surrounding the wound was carefully dried.

At the beginning, the dressings were changed every 72 hours. As the healing process proceeded and the impermeability of adhesive foil increased, the period between dressing changes was extended. Dressing changes took place in the treatment room. The patient received subcutaneously 50 mg of Dolargan (pethidine) before the dressing change procedure. Pain tolerance was well achieved. Continuous mode of work was applied at the negative pressure value of -120 mmHg. a total of 13 dressing kits were used during the first stage of negative pressure therapy, before making the decision of resection of the damaged head of the right humerus.

After the following dressing changes the total wound surface area has decreased. A gradual approximation of properly healing wound edges has been observed. Unfortunately a persistent leakage of dense purulent content with tissue fragments retained (Fig. 5). A chronic fistula penetrating to the level of humeral bone was diagnosed (Fig.6 and 7). Control X-ray examinations revealed the features of autolysis of the head of the humerus and the destruction of the elements of the right glenohumeral joint. We decided to remove the damaged bone structures. At the next stage of surgical management, a total resection of the damaged head of the humerus together with the present fistula to the medullary cavity, was performed. The procedure was extended by the partial resection of the proximal segment of shaft of the humerus. The elements of articular surface of the right glenoid fossa were refreshed. Post-operative wound was closed with interrupted sutures, 14 Fr Redon suction drain was applied.

On the second day after the surgery, an active bleeding from the post-operative wound was observed, which required an immediate surgical intervention and closure of the arterial vessel on the posterior surface of humeral stump. At the following stage of the procedure, the wound was left open for secondary healing. The level of blood supply in the surrounding muscles and periarticular tissues was also monitored (Fig. 8 and 9). The negative pressure therapy was applied once again in the treatment. The schedule of dressing applications and changes remained the same.The impermeability of film dressing enabled the dressing change every 72 – 96 hours at the bedside, in the treatment room. Prior to the dressing change procedure, the patient was administered an analgesic agent (Dolargan 50 mg subcutaneously). Pain tolerance was adequate. Complications in the form of bleeding were not observed (Fig. 10). After the resection of the fragment of the humerus, 4 dressing kits were used. In this case of wound treatment, the decrease of wound surface area, formation of normal granulation tissue, as well as cleansing of wound bed and edges with normal morphological condition of the surrounding tissues were also obtained.

In the above-described case, only complete elimination of the source of chronic infection in the form of infected head of the humerus, as well as ischaemic and necrotically altered periarticular muscles and soft tissues, created the proper conditions to optimal approximation of the bed and edges of the traumatic wound. Thanks to the application of negative pressure therapy, total wound size has been gradually and significantly reduced.

III. Discussion

Traumatic skin injury caused by surgical intervention and implantation of synthetic material increase the risk and probability of infection. In such cases the inflammatory process spreads through continuity to the bone, bone marrow and periarticular soft tissues. This type of pathology more often concerns adult patients. In case of hip joint endoprosthetics, the risk of infection is 0.3-1.7% and in case of knee joint reconstruction rises to approximately 0.8-1.9%.[13–15]

The wound healing process can be disturbed at any stage of the treatment. Many factors limit the natural processes of closing the tissue defect. The presence of necrotic and ischaemic tissue prevent wound coverage with normal granulation tissue

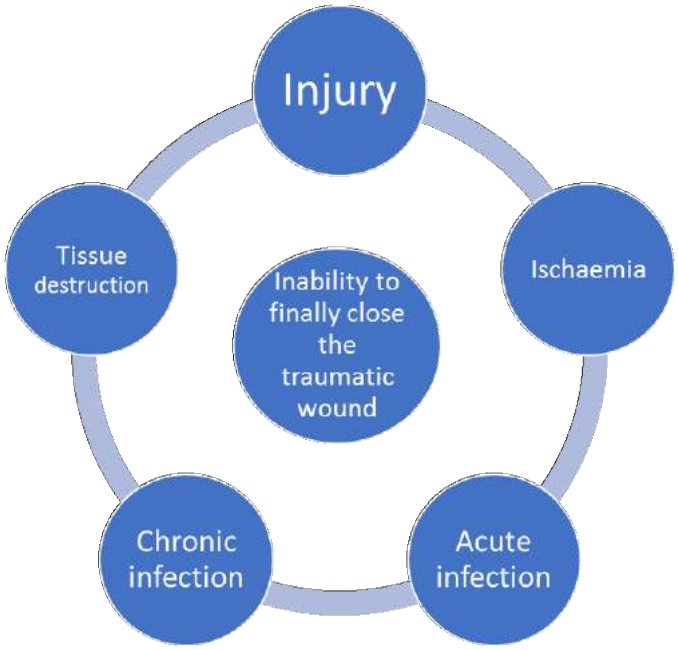

Figure 11. Cascade of adverse events preventing the closure of a traumatic wound

Table I
TREATMENT OF OSTEOMYELITIS. SURGICAL PROCEDURES.

Wide incision
Drainage of purulent content
Removal of necrotic and ischaemic tissues
Dressing, elimination of necrotic anatomical spaces
Appropriate bone stabilization
Maintaining physiological conditions in the joint
Negative pressure therapy (NPWT, NPWTi)
Filling the tissue defects

and scar. Local blood supply disturbances, and improper nerve stimulation in case of pareses, are factors that disturb the healing process. If necrotic tissues are not removed early enough, a chronic infection develops. Local infection process alters proper tissue architecture, leading to the destruction of surrounding tissues. The presence of necrotic foci, infections or foreign bodies significantly limits and alters tissue regeneration. The current state of knowledge unambiguously indicates the effectiveness and advantages of negative pressure therapy in the treatment of osteomyelitis. In December 2015,

Table II
INFECTIONS ARE THE DOMINANT AETIOLOGICAL FACTORS OF OSTEOMYELITIS.[16–18]

Staphylococcus aureus
Staphylococcus epidermidis – coagulase-negative *Staphylococcus* (CoNS),
Streptococcus viridans
Haemophilus influenzae
Escherichia coli
Klebsiella pneumoniae
Neisseria gonorrhoeae
Neisseria meningitidis
Mycobacterium tuberculosis
Pseudomonas aeruginosa
Fungal infections

Table III
DIAGNOSTIC PROCEDURES

Laboratory examinations:
Complete blood count
C-reactive protein
ESR
Imaging examinations:
Bones and joints X-ray
CT
MRI

Sayed described an effective application of negative pressure therapy in the treatment of primary osteomyelitis of sternum with mediastinal abscess in a newborn infant. It is the first description of the application of negative pressure in a neonatal patient.[19]

In the subject literature, the descriptions of the efficient attempts of the application of negative pressure therapy in such difficult disease entity as the infection of bones and bone marrow, appear more and more often. The application of negative pressure therapy in the treatment of extensive sternum injuries resulting from cardiac surgical interventions is indisputable and fully accepted. In such cases the terms DSWI (Deep Sternal Wound Infection) and SSWI (Secondary Sternal Wound Infection) are sometimes used. A complication in the form of a deep, infected sternal wound significantly prolongs the hospitalisation period, requires the administration of a broad-spectrum antibiotic therapy, puts the patient at risk of suffering and increases the costs of surgical care. The basis of the effective therapy is the removal of necrotic tissues and stimulation of the granulation process by negative pressure. The final closure of the defect is performed using grafts of pedicled muscle flaps, grafts of greater omentum or plastic surgery of chest walls with mobilised pectoral muscles.[20, 21]

If osteomyelitis develops in the location other than sternum, the situation becomes more complicated. However, the effective attempts of using negative pressure therapy in such cases are described more often.

Investigators from China report that negative pressure therapy is effective in the treatment of complicated traumatic calcaneal fracture with concomitant necrosis in the wound and delayed bone union.[22]

Another example from China indicates that negative pressure was useful in the treatment of traumatic osteomyelitis of tibia in 23 patients between 2007 – 2013. The infection process was reduced by preliminary, careful debridement of necrotic tissues and appropriate use of negative pressure therapy. Finally, the defect was closed with autologous bone grafts.[23]

Negative pressure therapy is very effective in the treatment of post-traumatic osteomyelitis. It contributes to eradication of chronic infection and facilitates the management of soft tissue defects, directly surrounding the bones. The mechanism of action concerns the activation of the desired granulation process, exudate elimination, cleaning wound environment of bacterial colonisation and reduction of bacterial biofilm. The reduced wound depth and surface area limits the necessity to apply demanding reconstruction surgery procedures.[24]

IV. Conclusion

The application of negative pressure therapy in the treatment of extensive traumatic wounds is a widely accepted therapeutic method. The attempts of using negative pressure for the treatment of osteomyelitis complicated by injury are taken more often and the final effects are promising.

The application of negative pressure enables, at the location of its action: faster formation of well blood-supplied granulation tissue, growth factor synthesis, cell proliferation, exudate elimination, oedema reduction and reduction in the number of bacterial colonies. Thanks to the activation of these processes, the reduction of wound depth and total wound surface area is possible. Based on the case described above it is worth noticing and remembering that prior optimal preparation of a traumatic wound is a necessary condition of effective negative pressure therapy. Primarily, a complete removal of ischaemic and necrotic tissues (debridement) is absolutely necessary. It enables the elimination of mechanical and bacterial contaminants, which prevent complete wound closure. On the basis of the above-described case it is evident that only after the removal of infected, morphologically altered bone tissue, in the form of the head and part of shaft of humeral bone as well as the elimination of chronic infected fistula of glenohumeral joint, the effective application of dressings in negative pressure system was possible.

V. Acknowledgments

I wish to extend special thanks to Tomasz Banasiewicz MD, PhD from Department of General and Endocrine Surgery and Gastroenterological Oncology, Poznań University of Medical Sciences for his support and confidence.

References

[1] P. J. Carek, L. M. Dickerson, and S. J. L, "Diagnosis and management of osteomyelitis." *Am Fam Physician*, vol. 63, pp. 2413–20, 2001.

[2] V. J. Mandracchia, S. M. Sanders, A. J. Jaeger, and W. Nickles, "Management of osteomyelitis," *Clinics in Podiatric Medicine and Surgery*, vol. 21, no. 3, pp. 335–351, jul 2004. [Online]. Available: http://dx.doi.org/10.1016/j.cpm.2004.03.008

[3] D. P. Lew and F. A. Waldvogel, "Osteomyelitis," *The Lancet*, vol. 364, no. 9431, pp. 369–379, jul 2004. [Online]. Available: http://dx.doi.org/10.1016/S0140-6736(04)16727-5

[4] "A good MATCH," *The Lancet*, vol. 364, no. 9445, p. 1575, oct 2004. [Online]. Available: http://dx.doi.org/10.1016/S0140-6736(04)17298-X

[5] S. Esposito, S. Leone, M. Bassetti, S. Borrè, F. Leoncini, E. Meani, M. Venditti, and F. Mazzotta, "Italian guidelines for the diagnosis and infectious disease management of osteomyelitis and prosthetic joint infections in adults," *Infection*, vol. 37, no. 6, pp. 478–496, nov 2009. [Online]. Available: http://dx.doi.org/10.1007/s15010-009-8269-2

[6] C. Coles and M. Gross, "Closed tibial shaft fractures: management and treatment complications. a review of the prospective literature," *Can J Surg*, vol. 43, no. 4, pp. 256–62, 2000.

[7] R. Rock, *Wound Care Advisor*, 2014. [Online]. Available: http://woundcareadvisor.com/wp-content/uploads/2014/03/GUIDELINES_M-A14.pdf

[8] K. Ballard and H. Baxter, "Vacuum-assisted closure," *Nurs Times*, vol. 97, pp. 51–52, 2001.

[9] P. Kim, C. Attinger, J. Steinberg, and K. Evans, "Negative pressure wound therapy with instillation: past, present, and future," *Surg Technol Int*, vol. 26, pp. 51–6, 2015.

[10] S. Gupta, A. Gabriel, J. Lantis, and L. Téot, "Clinical recommendations and practical guide for negative pressure wound therapy with instillation," *International Wound Journal*, vol. 13, no. 2, pp. 159–174, may 2015. [Online]. Available: http://dx.doi.org/10.1111/iwj.12452

[11] F. Kuehn, L. Schiffmann, F. Janisch, F. Schwandner, G. Alsfasser, M. Gock, and E. Klar, "Surgical endoscopic vacuum therapy for defects of the upper gastrointestinal tract," *Journal of Gastrointestinal Surgery*, vol. 20, no. 2, pp. 237–243, dec 2015. [Online]. Available: http://dx.doi.org/10.1007/s11605-015-3044-4

[12] N. R. Smallwood, J. W. Fleshman, S. G. Leeds, and J. S. Burdick, "The use of endoluminal vacuum (e-vac) therapy in the management of upper gastrointestinal leaks and perforations," *Surgical Endoscopy*, vol. 30, no. 6, pp. 2473–2480, sep 2015. [Online]. Available: http://dx.doi.org/10.1007/s00464-015-4501-6

[13] E. Jämsen, "Risk factors for infection after knee arthroplasty. a register-based analysis of 43, 149 cases," *The Journal of Bone and Joint Surgery (American)*, vol. 91, no. 1, p. 38, jan 2009. [Online]. Available: http://dx.doi.org/10.2106/JBJS.G.01686

[14] G. Peersman, R. Laskin, J. Davis, M. G. E. Peterson, and T. Richart, "Prolonged operative time correlates with increased infection rate after total knee arthroplasty," *HSS Journal*, vol. 2, no. 1, pp. 70–72, jan 2006. [Online]. Available: http://dx.doi.org/10.1007/s11420-005-0130-2

[15] L. Pulido, E. Ghanem, A. Joshi, J. J. Purtill, and J. Parvizi, "Periprosthetic joint infection: The incidence, timing, and predisposing factors," *Clinical Orthopaedics and Related Research*, vol. 466, no. 7, pp. 1710–1715, apr 2008. [Online]. Available: http://dx.doi.org/10.1007/s11999-008-0209-4

[16] L. S. Jorge, A. G. Chueire, and A. R. B. Rossit, "Osteomyelitis: a current challenge," *Brazilian Journal of Infectious Diseases*, vol. 14, no. 3, pp. 310–315, jun 2010. [Online]. Available: http://dx.doi.org/10.1590/S1413-86702010000300020

[17] V. Weston, "Guideline for the management of the hot swollen joint in adults with a particular focus on septic arthritis," *Journal of Antimicrobial Chemotherapy*, vol. 58, no. 3, pp. 492–493, jul 2006. [Online]. Available: http://dx.doi.org/10.1093/jac/dkl295

[18] G. Coakley, "BSR & BHPR, BOA, RCGP and BSAC guidelines for management of the hot swollen joint in adults," *Rheumatology*, vol. 45, no. 8, pp. 1039–1041, feb 2006. [Online]. Available: http://dx.doi.org/10.1093/rheumatology/kel163a

[19] S. Sayed, S. Prabhu, M. Thomas, C. A. McBride, and N. Alphonso, "Primary sternal osteomyelitis with extensive mediastinal abscess in a neonate," *The Annals of Thoracic Surgery*, vol. 100, no. 4, pp. e85–e87, oct 2015. [Online]. Available: http://dx.doi.org/10.1016/j.athoracsur.2015.05.133

[20] A. Akil, P. Schnorr, and K. Wiebe, "Behandlungsstrategien bei postoperativen sternuminfektionen," *Zentralblatt für Chirurgie - Zeitschrift für Allgemeine, Viszeral-, Thorax- und Gefäßchirurgie*, vol. 141, no. 01, pp. 93–101, oct 2015. [Online]. Available: http://dx.doi.org/10.1055/s-0035-1558097

[21] M. Chan, E. Yusuf, S. Giulieri, N. Perrottet, L. V. Segesser, O. Borens, and A. Trampuz, "A retrospective study of deep sternal wound infections: clinical and microbiological characteristics, treatment, and risk factors for complications," *Diagnostic Microbiology and Infectious Disease*, vol. 84, no. 3, pp. 261–265, mar 2016. [Online]. Available: http://dx.doi.org/10.1016/j.diagmicrobio.2015.11.011

[22] C. X. V. s. d. f. t. t. o. i. p. w. d. a. c. f. Liu G, Pan SP, *Zhongguo Gu Shang*, vol. 25, no. 9, pp. 782–4, 2012.

[23] Q. Du, H. Cong, Y. Shi, H. Jiang, and H. Sui, "Treatment of tibial traumatic osteomyelitis with vacuum sealing drainage combined with open bone graft." *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi*, vol. 28, no. 5, pp. 562–5, 2014.

[24] Y. Tan, X. Wang, H. Li, Q. Zheng, J. Li, G. Feng, and Z. Pan, "The clinical efficacy of the vacuum-assisted closure therapy in the management of adult osteomyelitis," *Arch Orthop Trauma Surg*, vol. 131, no. 2, pp. 255–259, dec 2010. [Online]. Available: http://dx.doi.org/10.1007/s00402-010-1197-x