

## Formulation of Reconstruction Protocol for Sacral Pressure Sore Defects.

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### Abstract

**Introduction:** Pressure sores are defined as soft-tissue injuries resulting from unrelieved pressure over a bony prominence. Decubitus ulcers term derived from Latin *decumbere*, to lie down – occur over areas that have underlying bony prominences when the patient is recumbent, e.g., the sacrum, trochanter, heel, and occiput. To formulate a reconstructive protocol for sacral pressure sore management, based on the outcomes of the study and existing literature, at the same time keeping in mind the resources available.

**Aims And Objective:** The aim of the study is to know, The causative and risk factors in development of sacral pressure sore. The types, planning and techniques of reconstructive methods. The merits and demerits of individual reconstructive options. The Clinical results after a surgical reconstruction of sacral pressure sores, The post operative management and the risk factors for recurrence and complications.

**Material And Methods:** This work includes the study of 50 patients who underwent reconstruction for pressure sores in the Department of plastic surgery, Government Rajaji Hospital, Madurai, between the period Nov 2015 to Feb 2017. The methods include obtaining history from patients, thorough clinical examination, necessary investigations and appropriate surgical reconstruction. Intraoperative, postoperative complications were noted and managed accordingly. Patients were advised regarding rehabilitation and referred back to their respective departments and advised regular follow up.

**Results:** In the fifty patients included in this study, the mean age was 46.36 years, with a range of 17 to 80 years. Traumatic paraplegia low spinal level (T9 and below) was found to be the most common aetiology in 22 patients. Infection was present in 84 % of all the pressure sore cases, which required serial debridement, antibiotic therapy and periodic dressings before attempting reconstruction. The majority of patients, 26 in number, had a Stage 3 pressure sore. Stage 4 sores was found in 32% of patients. Sacral pressure sore reconstruction was performed with a B/L VY Gluteus maximus myocutaneous flap in 6 patients, B/L skin rotation flap in 3 patients. Limberg flaps were used in 12 patients, Skin rotation flap done in 8 patients and gluteal artery perforator propellar flap in 8 patients.

**Conclusion:** In conclusion, Sacral pressure sores of stage II and III are best managed with any one of the following flaps, rotation or V-Y advancement skin flap, limberg flap, propeller flap. Sacral pressure sores of stage IV are best managed by one of the variants of gluteus maximus myocutaneous flaps. Effective control of infection by medical and surgical means in early stages, prevents progression of pressure sores, and promotes early healing.

**Keywords:** Pressure sores, flaps, infection, anaemia, dressing

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### I. Introduction

Pressure sores are defined as soft-tissue injuries resulting from unrelieved pressure over a bony prominence. Pressure sores are an ancient problem, observed even from autopsy of Egyptian mummies and have been reported in the Bible – Lazarus, Job and Isaiah thought to have had pressure ulcers. Decubitus ulcers term derived from Latin *decumbere*, to lie down – occur over areas that have underlying bony prominences when the patient is recumbent, e.g., the sacrum, trochanter, heel, and occiput. Terms such as *bedsore* or *decubitus ulcer* should be avoided as they suggest all the sores are a result of supine positioning. Although tissue destruction can occur over areas like the sacrum, scalp, shoulders, calves, and heels when a patient is lying down, the ischial sores occur in wheelchair-bound patients who are sitting, making “pressure sore” the better term.

There are many causative factors for pressure ulcers like shear, friction, denervation, poor nutrition, age, dementia, moisture and smoking, other than the pressure which is the main causative factor. Previous studies have shown that at the incidence of 3-10 % of hospitalised persons having pressure sores, the incidence rate for the development of a new pressure sore has been demonstrated to be much higher, with range of 7-30 %. They need 50% excess nursing time and also treated in hospital for longer periods require more hospital charges. Pressure ulcers occurs in very ill patients and who are kept in prolonged immobilisation. They are quiet frequent in intensive care units and in paraplegic individuals. Due to the complicity of the long lasting treatment, the expenses for their care are huge. 96% of pressure ulcers occur below the level of umbilicus.

In 1938, Davis suggested a flap of tissue can be used for replacing the unstable scar of a healed pressure sore. In 1947, Kostrubala and Greeley recommended bony prominence excision and giving padding for the bone exposed raw area with local fascia or muscle- fascia flaps. Conservative management were given to treat shallow and superficial pressure ulcers. Operative management given for deeper wounds with necrosis of deeper tissue, associated with severe infection, this will reduces the hospitalisation period, the need for frequent dressings, preventing enormous scars and the risk of subsequent infection. Early and successful management of Pressure sores ensures early rehabilitation of the patient .

## **II. Aim Of The Study**

1. The aim of the study is to know
2. The causative and risk factors in development of sacral pressure sore
3. The types, planning and techniques of reconstructive methods.
4. The merits and demerits of individual reconstructive options
5. The Clinical results after a surgical reconstruction of sacral pressure sores.
6. The post operative management, risk factors for recurrence and complications.
7. To formulate a reconstructive protocol for sacral pressure sore management, based on the outcomes of the study and existing literature, at the same time keeping in mind the resources available.

## **III. Material And Methods**

### **3.1 Materials**

This work includes the study of 50 patients who underwent reconstruction for pressure sores in the Department of plastic surgery, Government Rajaji Hospital, Madurai. The patients who were admitted in Orthopaedics, Neurology, Neuro surgery, General Medicine and General Surgery wards and subsequently developed pressure ulcers are referred to Department of plastic surgery, Government Rajaji Hospital, Madurai were studied between November 2015 – February 2017.

### **3.2 Methods**

The methods include obtaining history from patients, thorough clinical examination, necessary investigations and appropriate surgical reconstruction. Intraoperative, postoperative complications were noted and managed accordingly. Patients were advised regarding rehabilitation and referred back to their respective departments and advised regular follow up. The patients were followed up every week for two months, then monthly for a period of 6 months. The maximum follow up was for a period of 6 months. All information are entered in a proforma specially designed for this study.

### **3.3 Methodology**

The patients name age, sex, history of presenting illness and its duration were obtained. Past history of chronic medical and surgical illness noted. Personal history like smoking, alcohol consumption and diet pattern were obtained. Detailed physical examination of the pressure sore was made and tissue diagnosis was recorded and reconstruction planned accordingly. Neurological examination regarding sensory, motor impairment, bladder, bowel control, presence of contractures and spasms were noted.

Basic investigation like urine examination, blood Hb estimation, blood sugar and renal parameters like urea, creatinine were done. Serum protein levels were assessed. Wound swabs for culture and sensitivity were taken. X ray chest, X- ray of local part and ECG were taken. Hypoproteinemia was managed by appropriate nutritional supplementation. Infection was controlled by periodic debridement and antibiotics. Spasm relieved with Diazepam 5 mgs twice daily. Adequate relief of pressure was obtained by change of position every 2 hours, avoidance of moisture and nursing in a water bed provided.

All the patients were informed about the surgical procedures, the intra operative, post operative complication and rehabilitation. A detailed informed consent regarding the procedure and its complications was obtained. Patients were operated under general anesthesia and in prone position. Postoperatively all the patients were managed until suture removal. Blood transfusion was given in indicated patients. If necessary patients

were observed in the intensive respiratory unit for a couple of days. Patients were advised regarding rehabilitation and referred back to their respective departments and advised regular follow up.

The patients were followed up every week for 2 months, then monthly for a period of 6 months. The maximum follow up was for a period of 6 months.

#### IV. Analysis

The data obtained was analysed for the following factors

1. Age and Sex of the patient
2. The primary aetiology
3. (High spinal T8 and above), (low spinal-T9 and below)
4. Blood Hb level
5. Serum albumin level
6. Presence of infection
7. Stage of the pressure sore
8. Size of the pressure sore (small<5cm, Medium 5-10 cm, Large >10cm)
9. Site of pressure sore
10. Reconstructive method
11. Complications (Hematoma, Infection Dehiscence, Necrosis, Reccurence)

Factors associated with pressure ulcer development and the outcomes of surgical management were analysed and the results were obtained.

#### V. Observation And Results

In the fifty patients included in this study, the mean age was 46.36 years, with a range of 17 to 80 years.

**Table1** age And Gender

Age & Gender	< 20	21-40	41 - 60	61 -80	Total
Male	2	14	16	6	38
Female	2	3	4	3	12
Total	4	17	20	9	50

76 % patients were males and 24 % were females in our study.

Female to male ratio was 1: 3.16

**Table 2** PRIMARY DIAGNOSIS

Primary Diagnosis	No of cases	%
Traumatic Paraplegia – low spinal level	22	44
Traumatic paraplegia – high spinal level	2	4
Traumatic quadriplegia	5	10
Tuberculosis Paraplegia – low spinal level	2	4
Tuberculosis paraplegia –high spinal level	1	2
Tumour compression – paraplegia low spinal level	2	4
Tumour compression – Paraplegia high spinal level	1	2
Encephalitis	2	4
Head injury.	7	14
Fracture pelvis	3	6
Fracture neck of femur	3	6

Traumatic paraplegia low spinal level (T9 and below) was found to be the most common aetiology in 22 patients. Post traumatic paraplegia high spinal level and Post traumatic quadriplegia were present in 2 and 5 patients respectively. Tuberculosis and Tumour compression causing paraplegia were found in 3 patients each. Orthopaedic injuries like fracture neck of femur and fracture pelvis were the causative factors in 3 patients each. Pressure sore development due to alteration of conscious level were found in 9 patients.

**Table 3** Risk Factors For Pressure Sore Development

Risk Factors	No of cases	%
Hb < 10gm %	32	64
Serum albumin < 3gm%	28	56
Presence of Infection	42	84

Infection was present in 84 % of all the pressure sore cases, which required serial debridement, antibiotic therapy and periodic dressings before attempting reconstruction. Anaemia and Hypoalbuminaemia

were present in 32 and 28 patients respectively. Anaemia was treated with Iron supplements and blood transfusion wherever necessary. High protein diet was recommended for all patients with low albumin levels.

**Table – 4** size Of The Pressure Sore

Size	No of cases	%
Small (< 5 cm )	14	28
Medium (5-10cm)	24	48
Large (>10cm)	12	24

Medium sized pressure sore was noted in 48 % of patients. 14 patients had small pressure sores and remaining 12 had large pressure ulcers..

**Table – 5** Stage Of Pressure Sore

Stage	No of cases	%
Stage 2	8	16
Stage 3	26	52
Stage4	16	32

The majority of patients, 26 in number, had a Stage 3 pressure sore. Stage 4 sores was found in 32% of patients. Only 8 patients requiring reconstruction had stage 2 ulcers.

**Table 6** Method Of Reconstruction

Reconstruction	No of cases	%
B/L VY Gluteus Maximus Myocutaneous flap	6	12
Gluteus Maximus rotation flap	3	6
B/L VY Skin advancement flap	1	2
Skin rotation flap	8	16
B/L skin rotation flap	3	6
Limberg flap	12	24
Propellar flap	8	16
Double Z Rhomboid flap	2	4
Transverse Lumbosacral back flap	3	6
Secondary suturing	2	4
Split skin graft	2	4

Sacral pressure sore reconstruction was performed with a B/L VY Gluteus maximus myocutaneous flap in 6 patients, B/L skin rotation flap in 3 patients. Limberg flaps were used in 12 patients ,Skin rotation flap done in 8 patients and gluteal artery perforator propellar flap in 8 patients.

**Table – 7** Complications

Complications	No.of cases	%
Haematoma	7	14
Infection	6	12
Wound dehiscence	7	14
Flap necrosis	3	6
Recurrence	6	12

Haematoma and wound dehiscence were the commonest complications, encountered in 7 patients. The infection rate was found to be 12% while flap necrosis which were partial were found in 3 patients. In our 6 month follow up recurrence rate was found to be 12%

**ROTATION FLAP**





**BILATERAL ROTATION FLAP**



**LIMBERG FLAP**





**LUMBO SACRAL FLAP**



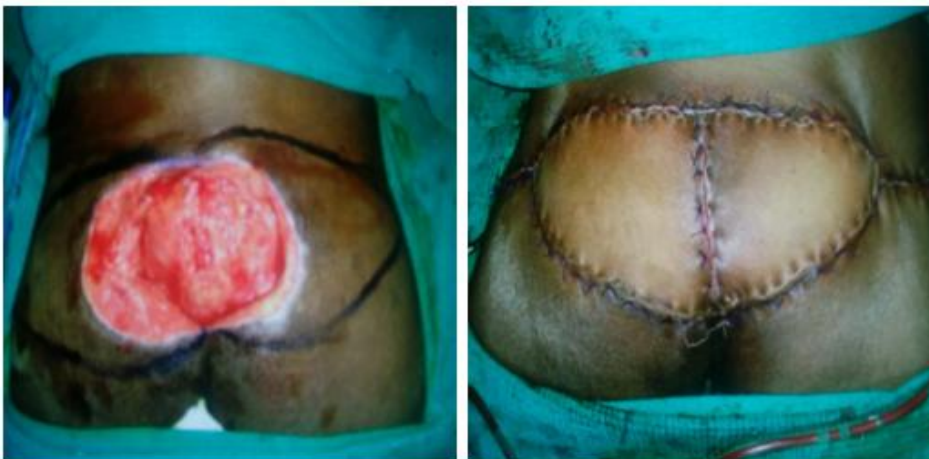
**GLUTEAL ARTERY PROPELLAR FLAP**



**PROPELLER FLAP**



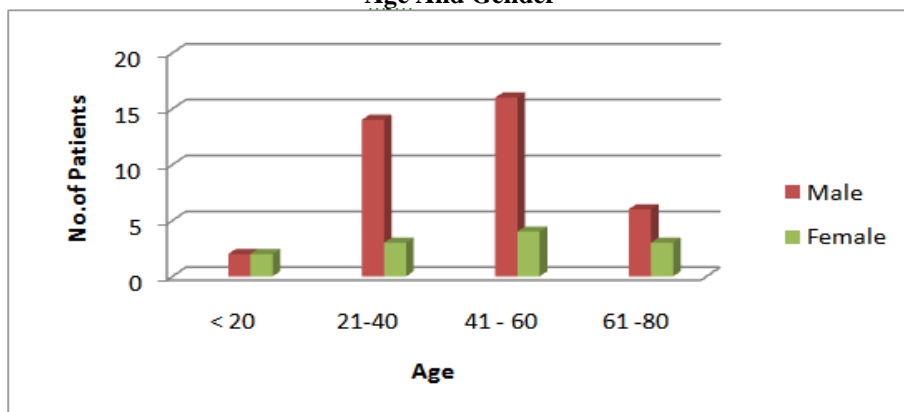
**B/L V-Y ADVANCEMENT FLAP**



**VI. Discussion**

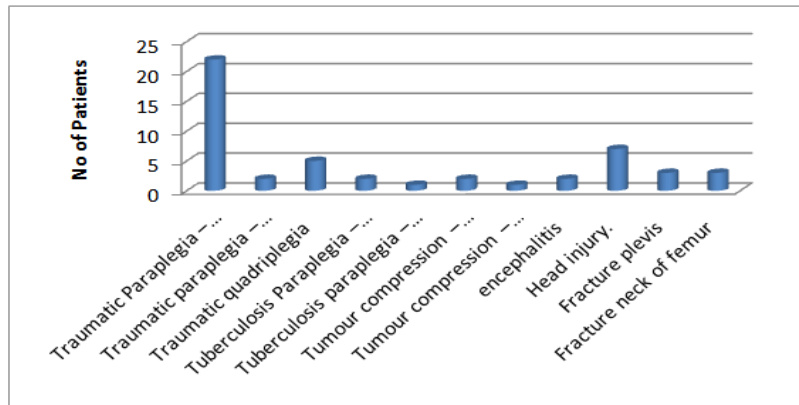
Reconstruction of pressure sore is performed to achieve early healing of ulcer in order to continue the rehabilitation process and treatment of primary illness which resulted in pressure ulcer.

**Age And Gender**



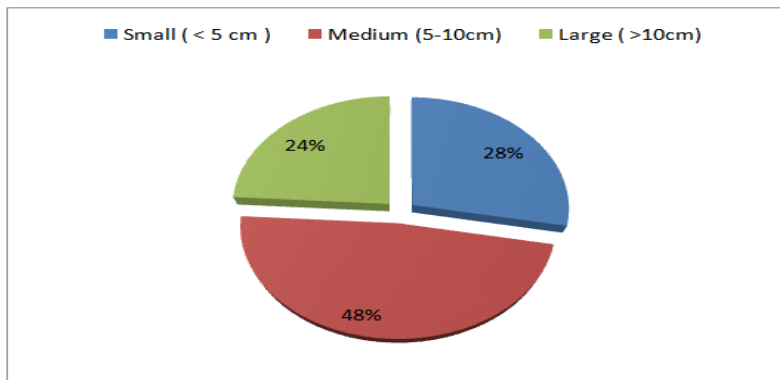
In our study of 50 patients who requiring reconstruction, the majority of the patients, 37 out of 50 patients were in between 20-60 age group, which is the most productive period of an individual. Men were thrice more commonly involved than females. This may be the fact that more men developed the primary neurological dysfunction resulting in pressure ulcer.

**VII. PRIMARY DIAGNOSIS**



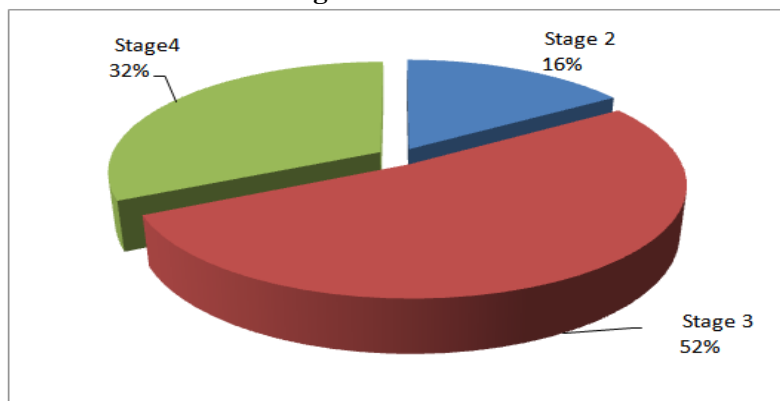
Traumatic aetiology was found to be the cause in more than 80% of patients. Most of the trauma resulted from road traffic accidents. Infectious aetiology namely encephalitis & tuberculosis accounted for only 10% of the patients. Patients developed anaemia (64%) and hypo albuminemia (56%) either due to the injury or subsequently, which when added to poor nursing care increases the chance of ischemia and subsequent development of pressure ulcers. Once a stage I pressure sore develops, the wound gets infected due to the presence of deep seated devitalised tissue and this becomes responsible for the progression of pressure sore in depth and size. Hence effective control of road traffic accidents plays an important role in primary prevention. Management of anaemia, hypoalbuminaemia with control of infection plays a prime role in secondary prevention of pressure ulcers.

**VIII. Size Of The Pressure Sore**



The size of the pressure sore between 5-10cms being the most common to get reconstructed.

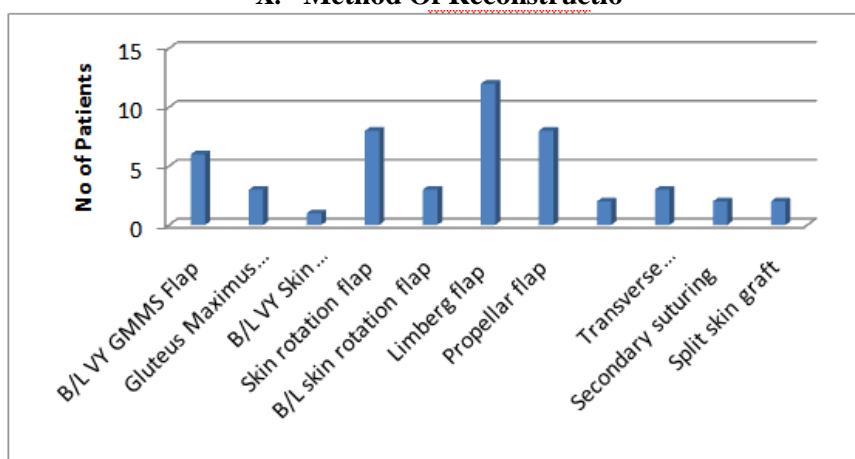
**IX. Stage Of The Pressure Sore**



Stage I and most of stage II pressure sores were managed conservatively, healed well and did not warrant reconstruction. Around 90% of the reconstruction were done only for stage III and stage IV pressure sores.



### X. Method Of Reconstructio



A thorough understanding of the principles and options of surgery allows the optimal procedure to be performed. In general all pressure sores needs debridement in the pseudo tumour approach as discussed earlier. Sacral pressure sore that are stage IV are better managed by a Gluteus maximus myocutaneous flap. It can be a rotation gluteus maximus for a small to medium midline ulcer, unilateral or bilateral V-Y advancement for a medium to large pressure ulcer. Superficial sacral sores can be reconstructed with skin flaps. The commonest flaps used was the limberg flap. It gives good results for a small sacral sore. When the size of ulcer is large, limberg flap application may lead to wound dehiscence. Hence a double Z rhomboid design can be used, which evenly distributes the tension around the raw area. Gluteal artery perforator propeller flaps were used in 8 patients for medium sized superficial ulcers. Rotation skin flaps and Transverse lumbo sacral back flaps are also viable options for sacral pressure sore management. In our study, haemotoma leading on to wound infection and dehiscence was found to be around 12%. This was more common in muscle flaps, where there is more dissection and dead space. A closed suction drain and perfect haemostasis is a must in the reconstruction of pressure sores. Partial flap necrosis was found more with skin flaps, which were salvaged and managed conservatively. Even with optimal preoperative, efficient intraoperative, good postoperative management and rehabilitation, pressure sores are prone for early or late recurrence. In our study recurrence rate was 12% for a 6month follow up period. This confirms the time tested fact that for pressure sores, prevention is better than cure.

### XI. Conclusion

1. Sacral pressure sores of stage II and III are best managed with any one of the following flaps, rotation or V-Y advancement skin flap, limberg flap, propeller flap.
2. Sacral pressure sores of stage IV are best managed by one of the variants of gluteus maximus myocutaneous flaps.
3. Effective prevention and management of anaemia and hypoalbuminaemia in addition to good nursing care reduced the incidence of recurrence of pressure sores.
4. Effective control of infection by medical and surgical means in early stages, prevents progression of pressure sores, and promotes early healing.
5. Trauma was the primary causative factor, Spinal cord injury leading to bed ridden condition, thus pressure sore happens. Hence control of road traffic accidents is of prime importance in primary prevention of pressure sores.

### Bibliography

- [1]. Robert foster: pressure sores. Stephen j.mathes (ed) : Plastic surgery, 2<sup>nd</sup> edition volume VI, chapter 157, 2006
- [2]. John D.Bauer, John S Mancoll, Linda G.Phillips : Pressure sores.
- [3]. Grabb and Smith's Plastic surgery, Part VII, chapter 74, 2007
- [4]. Berish Strauch, Luis O. Vasconez, Elizabeth J.Hall Findlay: Grabb's Encyclopedia of flaps, 2<sup>nd</sup> edition, section 4, part E,F,G, 1998.
- [5]. George C.Cormack, B.George H.Lamberty : The Arterial Anatomy of skin flaps, second edition, 1994.
- [6]. Davis JS. Operative treatment of scars following bed sores. Surgery. 1938;3:1.
- [7]. 1938;3:1.
- [8]. Kostrubala JG, Greeley PW. The problem of decubitus ulcers in paraplegics.
- [9]. Plast Reconstr Surg. 1947;2:403.
- [10]. Barbenel nJC, Jordan MM, Nicol SM, et al. Incidence of pressure-sores in the Greater Glasgow Health Board area. Lancet. Sep 10 1977;2 (8037):548-50.
- [11]. Lindan O.Greenway RM, Piazza JM. Pressure distribution on the surface of the human body. Evaluation in lying and sitting

- positions using a bed of springs and nails. Arch Phys Med Rehabil. May 1965;46:378-85.
- [12]. Barczak CA, Barnett RI, Childs EJ, et al. Fourth national pressure ulcer prevalence survey. Adv wound care. Jul – Aug 1997;10(4):18-26.
- [13]. Daniel RK, Faibisoff B. Muscle coverage of pressure points—the role of myocutaneous flaps. Ann Plast Surg. Jun 1982;8(6):446-52.
- [14]. Evans GR, Lewis VL Jr, Manson PN, et al. Hip joint communication with pressure sore: the refractory wound and the role of Girdlestone arthroplasty. Plast Reconstr Surg. Feb 1993;91 (2):288-94.
- [15]. Atri SC, Misra J, Bisht D, et al. Use of homologous platelet factors in achieving total healing of recalcitrant skin ulcers. Surgery. Sep 1990;108(3):508-12.
- [16]. Robson MC, Phillips LG, Thomson A, et al. Platelet-derived growth factor BB for the treatment of chronic pressure ulcers. Lancet. Jan 4 1992;339(8784):23-5.
- [17]. Mustoe TA, Cutler NR, Allman RM, et al. A phase II study to evaluate recombinant platelet-derived growth factor- BB in the treatment of stage 3 and 4 pressure ulcers. Arch Surg. Feb 1994;129(2):213-9.
- [18]. Anthony JP, Mathes SJ, update on chronic osteomyelitis. Clin Plast Surg. Jul 1991;18(3):515-23.
- [19]. Anthony JP, Mathes SJ, Alpert BS. The muscle flap in the treatment of chronic lower extremity osteomyelitis: results in patients over 5years after treatment. Plast Reconstr Surg. Aug 1991;88(2):311-8.
- [20]. Bennett RG, Bellantoni MF, ouslander JG, Air-fluidized bed treatment of nursing home patients with pressure sores. J Am Geriatr Soc. Mar 1989;37(3):235-42.
- [21]. Berkwits L, Yarkony GM, Lewis V Marjolin’s ulcer complicating a pressue ulcer: case report and literature review. Arch Phys Med Rehabil. Nov 1986;67(11):831-3.
- [22]. Berlowitz DR, Wilking SV, Risk factors for pressure sores. A comparison of cross-sectional and cohort-derived data. J Am Geriatr Soc. Nov 1989;37(11):1043-50.
- [23]. Brown Sequad E. Experimental research applied to physiology and pathology. Med Exam Rec Med Sci. 1852;16:481.
- [24]. Bruck JC, Buttemeyer R, Grabosch A, et al. More arguments in favour of myocutaneous flaps for the treatment of pelvic pressure sores. Ann Plast Surg. Jan 1991;26(1):85-8.
- [25]. Capen DA, Staged total thigh rotation flap for coverage of chornic recurrent pressure sores. Contemp Orthop.1988;16:23.
- [26]. Charcot JM. Lectures on the Diseases of the Nervous System. 2<sup>nd</sup> ed. Sigerson G, trans. Delivered at La Saltpetriere. Philadelphia: Henry C Lea; 1879.
- [27]. Colen SR. Pressure sore. In: McCarthy Plastic Surgery. Philadelphia, Pa: WB Saunders Co; 1990:3797-838.
- [28]. Crenshaw RP, Vistnes LM. A decade of Pressure sore research: 1977-1987. J Rehabil Res Dev. Winter 1989;26(1):63-74.
- [29]. Dansereau JC, Conway H. Closure of decubiti in paraplegics. Report of 2000 cases. Plast Reconstr Surg. May 1964;33:474-80.
- [30]. Dinsdale SM. Decubitus ulcers: role of pressure and friction i causation.
- [31]. Arch Phys Med Rehhabil. Apr 1974;55(4):147-52.
- [32]. El-Toraei I, Chung B. The management of pressure sores. J Dermatol Surg Oncol. Sep-Oct 1977;3(5):507-11.
- [33]. Esposito G, Di Caprio G, Ziccardi P, et al. Tissue expansion in the treatment of pressure ulcers. Plast Reconstr Surg. Mar 1991;87(3):501-8.
- [34]. Evans GR, Duffresne CR, Manson PN. Surgical correction of pressure ulcers in an urban center: isit efficacious? Adv Wound Care Jan 1994;7(1):40-6.
- [35]. Ferrell BA, Osterweil D, Christenson P. A randomized trial of low-air-loss beds for treatment of pressure ulcers. JAMA. Jan 27 1993;269(4):494-7.
- [36]. Geogiade N, Pickrell K, Maguire C. Total thigh flaps for extensive decubitus ulcers. Plast reconstr surg (1946). Mar 1956;17(3):220-5.
- [37]. Ger R, Levine SA. The management of decubitus ulcers by muscle transposition. An 8 year review. Plast Reconstr Surg. Oct 1976;58(4):419-28. 34.Gould WL, Montero N, Cukic J, et al. The “split “ gluteus maximus musculocutaneous flap. Plast Reconstr Surg. Feb 1994;93(2):330-6.
- [39]. Hill HL, Brown RG, Jurkiewicz MJ. The transverse lumbosacral back flap.
- [40]. Plast Reconstr Surg. Aug 1978;62(2):177-84.
- [41]. Hurwitz DJ. The gluteus maximus muscle musculocutaneous flap. In: Serafin D,ed. Atlas of Microsurgical Composite Tissue Transplantation. Philadelphia, Pa: WB Saunders Co; 1996:259-70.
- [42]. Hurwitz DJ, Swartz WM, Mathes SJ. The gluteal thigh flap: a reliable, sensate flap for the closure of buttock and perineal wounds. Plast Reconstr Surg. Oct 1981;68(4):521-32.
- [43]. Hurwitz DJ, Walton RL. Closures of chronic wounds of the perineal and sacral regions using the gluteal thigh flap. Ann Plast Surg. May 1982;8(5):375-86.
- [44]. Husain T. An experimanetal study of some pressure effects on tissues, wit reference to the bed-sore problem. J Pathol Bacteriol. Oct 1953;66(2):347-58.
- [45]. Keane FX. The function of the rump in relation to sitting and the Keane Reciprocating Wheelchair Seat. Paraplegia. Feb 1979;16(4):390-402.
- [46]. Koshima I, Moriguchi T, Soeda S, et al. The gluteal perforator based flap for repair of sacral pressure sores. Plast Reconstr Surg. Apr 1993;91(4):678-83.
- [47]. Landis DM. Studies of capillary blood pressure in human skin. Heart. 1930;15:209.
- [49]. Le KM, Madsen BL, Barth PW, et al. An in-depth look at pressure sores using monolithic silicon pressure sensors. Plast Reconstr Surg. Dec 1984;74(6):745-56.
- [50]. Lee HB, Kim SW, Lew DH, et al. Unilateral multilayered musculocutaneous V-Y advancement flap for the treatment of pressure sore. Plast Reconstr Surg. Aug 1997;100(2):340-5;discussion 346-9.
- [51]. Lewis VL Jr, Bailey MH, Pulawski G, et al. The diagnosis of osteomyelitis in patients with pressure sores. Plast Reconstr Surg. Feb 198;81(2):229-32.
- [52]. Lindan O, Etiology of decubitus ulcers: an experimental study. Arch Phys Med Rehabil. Nov 1961;41:774-83.
- [53]. Mancoll JS, Phillips LG. Pressure sores. In: Archaeur BM, Eriksson E, Guyuron B et al, eds. Plastic Surgery, Indication Operations and Outcomes, st. Louis: Mosby; 2000:447-62.

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