

Role of Plastic Surgeon in the Management of Pressure Ulcers during Rehabilitation of Patients with Traumatic Spinal Cord Injury: A Tertiary Hospital Experience

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ABSTRACT

Background: Pressure ulcers and their management represent one of the most challenging situations following traumatic spinal cord injury (SCI). It requires frequent hospitalizations and hence aggravates the physical, psychological and socioeconomic burden of patients and their caregivers. Early surgical intervention will help in reducing the morbidity as well as improve the quality of life of these patients. In this study, we present a retrospective review of reconstructive surgeries for pressure sores highlighting the role of the plastic surgeon in the rehabilitation of traumatic SCI.

Methods: A three-year retrospective review (January 2014–December 2017) of 25 traumatic SCI patients who underwent reconstructive surgeries for pressure ulcers in the Department of Plastic Surgery in a Tertiary Care Government Hospital in South India was done. Variables like demographic and clinical details, reconstructive procedures done, postoperative complications, duration of hospital stay and relation of wound complication with serum albumin were statistically analyzed and interpreted using statistical package for social sciences (SPSS) software.

Results: Twenty-five male patients with age between 22 and 69 years (mean age = 49.4±12.24) were analyzed. 88% of the patients (n = 22) had paraplegia, and 12% had quadriplegia. 12% of patients had a cervical spinal injury, while 88% had a thoracolumbar injury. Mean duration of hospital stay was 36.5 days. Of the 25 patients, 68% (n = 17) had pressure sores at multiple sites while the rest had a single pressure sore. Of the total 49 pressure sores, 30 were ischial, 11 sacral, 7 trochanteric and one perineal pressure sore. Forty-five pressure sores were of grade II/IV and was managed with various flap reconstructions. One sacral pressure sore and one ischial pressure sore (grade II) underwent excision and primary closure. Split skin grafting was done for 2 sacral pressure sores. Postoperative wound complications were analyzed and there was a significant relation between hypoalbuminemia and major wound complications (Fischer exact p = <0.0001)

Conclusion: Plastic surgeons have an important role to play in the rehabilitation phase of traumatic spinal cord injury patients with pressure sores. Early reconstructive surgeries for pressure sores will prevent the development of complications and provide better quality of life (QOL) for these patients.

Keywords: Ischial, Management, Plastic surgeon, Pressure ulcers, Reconstructive surgery, Rehabilitation, Sacral sores, Traumatic spinal cord injury, Trochanteric sores.

Abbreviations

SCI–Traumatic spinal cord injury

QOL–Quality of life

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INTRODUCTION

Pressure sores and their management represent one of the most challenging situations following traumatic spinal cord injury and it requires frequent hospitalizations as well as cause physical, mental and financial burden to patients and caregivers. Complications like osteomyelitis, destruction of joints, necrosis of muscle and soft tissue, or erosion into neighbouring vital structures may lead to life-threatening sepsis and increases the mortality.

The incidence of pressure ulcers following spinal cord injury is 25 to 66%.¹ Patients with higher-level spinal cord injuries are more susceptible to the development of pressure sores than those with lower-level lesions. The lack of protective sensation, insufficient home care and lack of good quality pressure-relieving equipment, and comorbidities (e.g., diabetes, anemia, malnutrition) contribute to the development of pressure ulcers in the rehabilitation phase of traumatic spinal cord injuries.^{2,3} Pressure ulcers result in an exponential increase in the healthcare burden and financial requirement for these patients and their families.

Presence of pressure ulcer reduces the quality of life and hence prevention of pressure ulcer should be an important goal in the rehabilitation phase of traumatic spinal cord injuries. In patients with pressure sores, early reconstructive surgeries will reduce the complications and readmission rates, thereby, improve the quality of life.

In this retrospective study, we present our role as plastic surgeons in the management of pressure sores

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in the rehabilitation phase of the traumatic spinal cord injuries in a Tertiary Government Hospital for three years. The primary aim in the reconstruction of a pressure sore in a paraplegic/quadruplegic patient is to give adequate soft tissue padding for support and protection over bony prominences, which is crucial in the prevention of recurrent breakdown. Choice of the flap for reconstruction is influenced by the location of pressure ulcers, size and dimension of the ulcer, availability of local tissues and their vascularity, the ambulatory status of the patient as well as by the surgeon's preference.

METHODS

The study was performed retrospectively in the Department of Plastic, Reconstructive Surgery in a Tertiary Care Government Hospital in South India, during the 3 years from January 2014 to December 2017. Inclusion criteria was patients of any age and sex with pressure ulcers following traumatic spinal cord injuries that required surgical intervention. Patients with pressure ulcers managed conservatively were excluded.

The patient's demographic and clinical details, preoperative serum nutritional markers like serum albumin, surgical procedures done, postoperative complications if any, and duration of hospital stay were collected from the hospital records. The postoperative complications were categorized into two:

1. Major wound complications, which included, wound dehiscence and flap necrosis
2. Minor complications such as postoperative wound infection, seroma, and hematoma.

The relationship of major wound complications with serum albumin was also studied.

Surgical Procedure

All the procedures were performed by the surgical team of the same department.

The patients admitted were given adequate preoperative preparation before taking up for the procedure. This included:

- Proper counseling regarding the frequent change of position, proper skin care, use of special beds like air bed/ water bed, proper nutrition with high calorie-high protein low residue diet, muscle strengthening as well as respiratory exercises were given and it was ensured that the patients followed the advice properly.
- Preoperative correction of nutritional parameters like hemoglobin (≥ 10 g/dL), serum albumin (≥ 3 g/dL) was done.
- Bowel preparation was done with preoperative low residue diet, and bowel washes to avoid inadvertent soiling of the surgical field and wound site.
- Spasticity if present was treated preoperatively with skeletal muscle relaxants like Baclofen.

- Patients were acclimatized to prone position preoperatively in cases of sacral and ischial pressure.

All the reconstructive surgeries were done under General Anaesthesia. Surgeries were done in the prone position in sacral pressure sores and ischial pressure sores. Trochanteric pressure sores were operated on the lateral position. Pseudotumor excision of the ulcer and underlying bursa was done before reconstruction. This was done by packing the cavity of the pressure sore with a gauze soaked with methylene blue/ betadine and closing the mouth of the ulcer with silk suture. This was removed en masse ensuring that no stained tissue was left behind. In the case of grade IV pressure, all the granulations on the bone on the floor were curetted out. The underlying bone was inspected intraoperatively for any osteomyelitis, and debridement was done judiciously as aggressive removal of the underlying bony prominence will shift the pressure points to the opposite side or to an area like perineum where it is very difficult to manage. Local flaps were done in almost all cases except split skin grafting for two sacral pressure sores and excision and primary closure for one sacral pressure sore and one ischial pressure sore, in which all the pressure sores were grade II. Postoperatively suction drains were put for all cases.

During the immediate postoperative period, minor wound complications like hematoma formation, seroma collection, and wound infections were present in about 15 cases. Hematomas and seromas occurred mainly due to blockage of the suction drains. They were managed conservatively by repeated aspirations and most of the flaps settled. Wound infections were managed conservatively with culture-specific antibiotic therapy. Five patients had major wound complication like flap necrosis and wound dehiscence which required secondary procedures like flap readvancement and secondary suturing. All these five patients had serum albumin less than 3g/dL at the time of admission and were corrected preoperatively.

Sacral Pressure Sore—Representative Case

A 35-year-old male patient, with a history of fracture T12–L1, paraplegic for 4 years, presented with grade 4 sacral pressure. Pseudotumour excision and bilateral inferiorly based gluteal rotation advancement flaps were done. Postoperative periods were uneventful (Fig. 1).

Ischial Pressure Sore—Representative Cases

Case I

A 50-year-old male presented to the hospital with grade IV ischial pressure sore on the right side, following

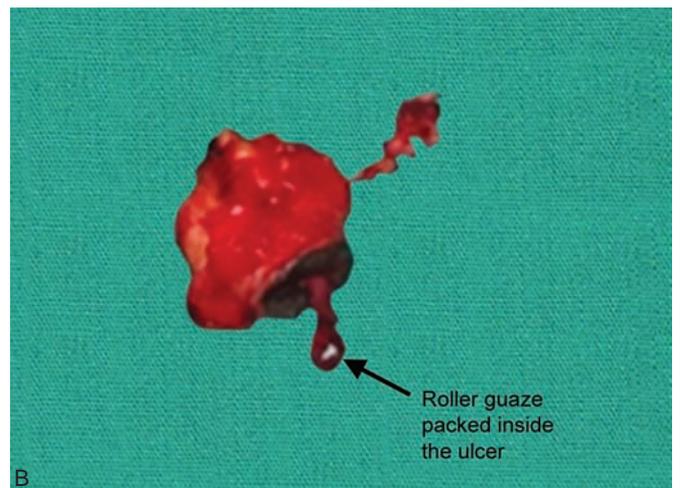


Figs 1A and B: (A) Preoperative picture of Grade 4 sacral pressure sore; (B) Postoperative picture showing bilateral gluteal rotation advancement flaps

post-traumatic thoracolumbar spine fracture ten years back. Pseudotumour excision of the pressure sore was done and a medically based posterior thigh rotation flap cover was done. Postoperative period was uneventful (Fig. 2).

Case II

A 30-year-old male patient with a history of paraplegia for six years presented with left grade IV ischial pressure sore and grade II sacral pressure sore. Gluteus maximus musculocutaneous transposition flap was done.



Figs 2A to C: (A) Grade IV ischial pressure ulcer right; (B) Pseudotumor excision specimen of pressure sore with the removed osteomyelitis ischium; (C) Postoperative picture showing medially based posterior thigh rotation flap



Figs 3A and B: (A) Intraoperative picture after pseudotumor excision of ischial pressure sore with flap marking; (B) Postoperative picture showing Gluteus maximus myocutaneous transposition flap

Postoperative period was uneventful. Sacral pressure sore was excised and closed primarily (Fig. 3).

Trochanteric Pressure Sore—Representative Case

A 37-year-old male patient with a history of cervical spine fracture, quadriplegia with spasticity, presented with Grade IV trochanteric pressure sore on the right side of five years duration. Pseudotumor excision was done and the defect was closed with a tensor fascia lata transposition flap. The secondary defect of the flap was resurfaced with a split-thickness skin graft (Fig. 4).

Perineal Pressure Sore—Representative Case

A 55-year-old male patient with a history of post-traumatic paraplegia twenty years back had a history of multiple recurrent ischial and perineal pressure sore. Six surgeries were done for both sides and he finally underwent hip disarticulation bilaterally and the wound was closed with bilateral total thigh flaps. He again presented with perineal pressure sore with urethral

fistula which was repaired with the re-advancement of the total thigh flap (Fig. 5).

Statistical Analysis

Study data were entered in Excel and analyzed using statistical package for social sciences (SPSS) version 16, Chicago inc.

Descriptive analysis of the cases was done. Inferential statistics were done with Chi-square Fischer exact test.

RESULTS

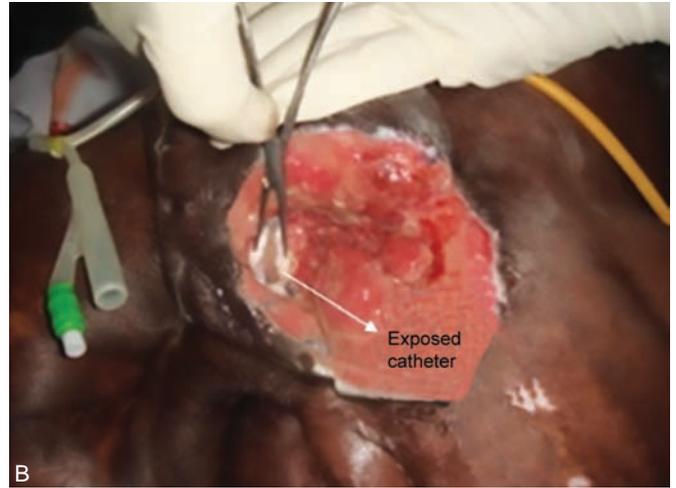
Demographics

A total of 25 patients (n = 25) were admitted in the department during the study period. All the patients were males and all of them had post-traumatic etiology. The age of patients ranged from 22 to 69 years (mean age = 49.4+/-12.24). Eighty-eight percent of the patients (n = 22) had paraplegia while 12% (n = 3) had quadriplegia (Fig. 6).

The level of spinal injury was cervical in 12% of patients (n = 3), while the rest (n = 22) had a thoracolumbar spinal injury (Fig. 7).



Figs 4A and B: (A) Preoperative picture showing Grade IV trochanteric ulcer; (B) Postoperative picture showing tensor fascia lata myocutaneous transposition flap. Secondary defect was skin grafted



Figs 5A and B: (A) Hip disarticulation and total thigh flap cover given bilaterally; (B) Perineal pressure sore with urethral involvement. Catheter is exposed

Table 1: Types of pressure sores and the number of patients

| Sl. no | Type of pressure sores | Number of patients |
|--------|-------------------------|--------------------|
| 1. | Unilateral ischial | 6 |
| 2. | Bilateral ischial | 12 |
| 3. | Sacral | 11 |
| 4. | Unilateral trochanteric | 5 |
| 5. | Bilateral trochanteric | 1 |
| 6. | Perineal (others) | 1 |

Table 2: Total number of pressure sores in each type.

| | |
|--------------|----|
| Ischial | 30 |
| Sacral | 11 |
| Trochanteric | 7 |
| Perineal | 1 |
| Total | 49 |

Mean duration of hospital stay was 36.5 days.

Of the twenty-five patients, seventeen patients (68%) had pressure sores at multiple sites while the rest had single pressure sore (Fig. 8).

The number of patients with each type of pressure sore is shown in (Table 1).

The total number of pressure sores in twenty-five patients were forty-nine. There were thirty ischial pressure sores, eleven sacral pressure sores, seven trochanteric pressure sores, and one perineal pressure sore (Table 2).

The pressure sores which underwent flap reconstruction were either grades III or IV. One sacral pressure sore and one ischial pressure sore was grade II

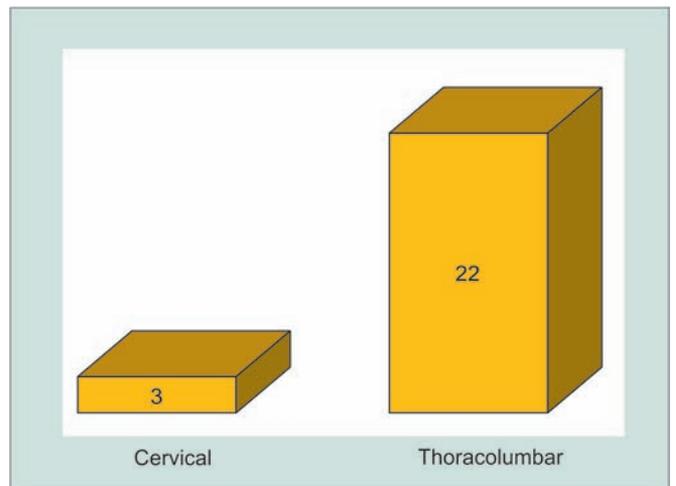


Fig. 7: Level of spinal injury

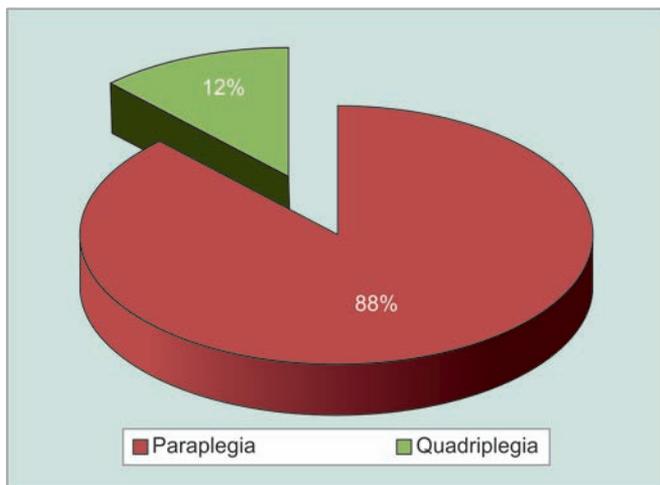


Fig. 6: Percentage of patients with neurological deficits

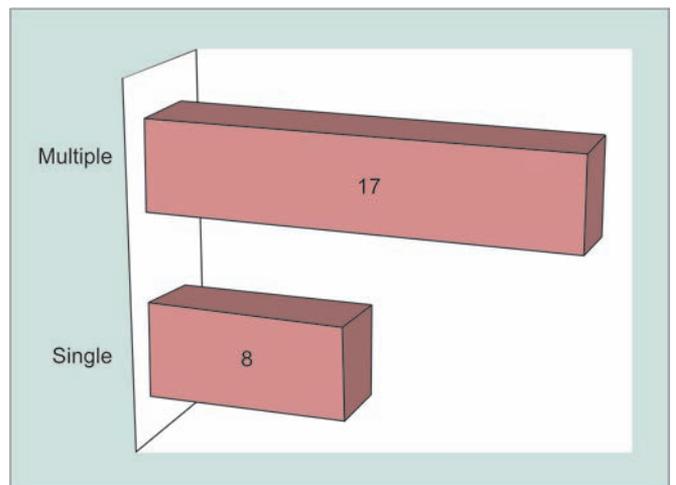


Fig. 8: Showing the number of pressure sores

Table 3: Reconstructive flap surgeries done for Ischial pressure sore

| Sl no. | Procedure | Number of cases |
|--------|---|-----------------|
| 1. | Limberg flap | 3 |
| 2. | Myocutaneous hamstring muscle advancement flap | 4 |
| 3. | Medially based posterior thigh rotation advancement flap cover | 8 |
| 4. | Laterally based posterior thigh rotation advancement flap cover | 5 |
| 5. | V-Y advancement flap | 6 |
| 6. | Gluteal thigh flaps | 2 |
| 7. | Gluteus maximus myocutaneous transposition flap | 1 |
| 8. | Excision and primary closure | 1 |

with a dimension of less than 5 cm in size, underwent excision and primary closure.

Medially based posterior thigh rotation flaps were done in eight cases and laterally based rotation advancement flaps were done in five cases of ischial pressure sores. V-Y advancement flaps and Myocutaneous hamstring advancement flaps were done in six and four cases respectively. Limberg flaps, gluteus maximus myocutaneous transposition flaps and gluteal thigh flaps were the other flaps done for the reconstruction of ischial pressure sore during the period (Table 3).

There were eleven cases of sacral pressure sore during the study period. Seven patients underwent gluteal rotation advancement flaps unilateral/bilateral for reconstruction. Limberg flap reconstruction was done for one patient. One patient underwent excision and primary closure while split skin grafting was done for two cases (Table 4).

There were seven trochanteric pressure sores during the period, of which three underwent tensor fascia lata transposition flap while four underwent tensor fascia lata V-Y advancement flaps (Table 5).

One case of perineal pressure sore with urethral fistula was present in a paraplegic patient who had undergone bilateral hip disarticulation and total thigh flap reconstruction for multiple recurrent pressure sores. The perineal pressure sore and urethral fistula was repaired with readvancement of the total thigh flap.

During the immediate postoperative period, minor wound complications like hematoma formation, seroma collection, and wound infections were present in about 15 cases. Five patients had major wound complication like flap necrosis and wound dehiscence which required secondary procedures like flap readvancement and

Table 5: Reconstructive surgeries for trochanteric pressure sores

| Sl no | Procedure | Number of patients |
|-------|--|--------------------|
| 1. | Tensor fascialata transposition flap | 3 |
| 2. | Tensor fascialata V-Y advancement flap | 4 |

Table 4: Reconstructive surgeries done for sacral pressure sore

| Sl No: | Procedure | Number of patients |
|--------|------------------------------|--------------------|
| 1. | Gluteal rotation flap | 7 |
| 2. | Limberg flap | 1 |
| 3. | Split skin grafting | 2 |
| 4. | Excision and primary closure | 1 |

secondary suturing. All these five patients had serum albumin less than 3 g/dL at the time of admission and were corrected preoperatively. The relation of the serum albumin and wound dehiscence was found to be statistically significant ($p \leq 0.0001$) (Table 6).

DISCUSSION

Pressure sores or pressure ulcers form a common problem causing prolonged morbidity as well as a financial burden to persons with traumatic spinal cord injuries with motor and sensory deficits. Managing a paraplegic or quadriplegic patient with a pressure ulcer is a challenge to the caregiver, as well as for the reconstructive surgeon.

The pathogenesis involves not only the unrelieved pressure occurring in the already insensate soft tissues over bony prominences, but factors like constant moisture, shear, friction, malnourishment, and infections also contribute to the development of pressure ulcers in patients with spinal cord injuries.^{2,3} In the early phases of spinal cord injuries, the patients are mostly managed in the supine position until the spinal fractures are stabilized and the associated traumatic injuries are treated. Hence the most common area of pressure sore in the acute phase is sacral area.⁴ During the rehabilitation phase of spinal injuries, the patients tend to be in a wheelchair in a sitting position. Hence ischial pressure sores from the most common type of pressure ulcers in the rehabilitation phase.⁴ Immobility with impaired sensation along with incontinence, spasticity, malnourishment as well as psychosocial issues like depression, financial constraints and factors related to caregivers, all will contribute to the development of pressure ulcers. Spasticity, characterized by hyperreflexia, clonus, and increased muscle tone, is commonly seen in SCI, is not included in the pressure sore risk scales.^{1,5} But spasticity increases the risk of developing pressure sores by a direct increase in mechanical stress, altered weight distribution, as well as complicating patient positioning, skin inspection, and hygiene.^{4,5}

Table 6: Level of serum albumin and postoperative major wound complications

| Major wound complications | Albumin <3 G/Dl | Albumin >3 G/Dl | Total |
|---------------------------|-----------------|-----------------|-------|
| Present | 5 | 2 | 7 |
| Absent | 0 | 18 | 18 |
| Total | 5 | 20 | 25 |

$\chi^2 = 16.071$ df = 1 $p = <0.0001$; Fischer exact p (one sided) = <0.0001

The most commonly used classification is the National Pressure Ulcer Advisory Panel Staging System (NPUAP), a modification of Shea's original classification.^{4,5} NPUAP classifies pressure ulcers into four grades in the increasing order of severity. Only grades III and IV require surgical intervention with the other two being managed conservatively with adequate pressure relieving mechanisms, topical and systemic antibiotics as well as nutritional support.

Nonsurgical Management of Pressure Sores

Pressure Relief

Pressure relief forms the most important modality in the management of pressure sores. This includes a frequent change of position as well as the use of various support surface devices.^{6,7} Support surface devices are mainly divided into two categories:

Constant low-pressure devices (CLP devices) distribute pressure over a large area, e.g., low air loss (LAL) beds, air-fluidized beds alternating pressure devices (AP devices) which vary the pressure under the patient, avoiding prolonged pressure over a single anatomic point.

Control of Spasticity

Control of spasticity improves patient positioning, weight distribution, and hygiene.^{6,7} It also prevents the chance of wound dehiscence due to undue tension on the surgical wound.

Correction of Malnutrition

This is important as healing is significantly affected in malnutrition.⁸ Correction of malnutrition and the nutritional markers like serum protein and albumin as well as supplementation of micronutrients like vitamin C and zinc all form important preventive as well as preoperative measures in the management of pressure sores.

Control of Infection

Osteomyelitis is an important complication of deep pressure sores. Bone biopsy, as well as culture-specific antibiotics, form an important adjunct to surgery in dealing with osteomyelitis.

Wound Care

Debridement with the removal of necrotic tissue forms the mainstay in the management of pressure sores. Although enzymatic debridement with enzymes like papaine, or biological debridement with maggots which removes necrotic tissue sparing the normal tissue has been mentioned in literature, none gained importance over sharp surgical debridement.

Skin Care

Ideal skin care should include proper cleaning, hydration, protecting the skin. Replenishing with emollients, moisturizers, and barrier skin protectors in the presence of incontinence and stomas also form an important part in the skin care in paraplegic patients.

Management of Incontinence

This helps to keep the skin dry and infection free.

Negative Pressure Wound Therapy

NPWT refers to the use of topical application of negative pressure in a wound thereby promote healing. Vacuum-Assisted Closure (VAC) is the most commonly available wound closure system.

Surgical Management of Pressure Sores

Conway and Griffith enumerated the basic tenets of surgical treatment of pressure sores.^{4,9} This includes:

Radical excision of the ulcer along with the surrounding scar, underlying bursa and calcified soft tissues-(pseudotumor excision).

Removal of the underlying bony prominence especially if there is osteomyelitis. A bone biopsy is mandatory if there is suspected osteomyelitis. Bony debridement should be done judiciously since radical excision of the bone with the result in shifting the pressure points which later on result in pressure ulcers elsewhere like perineal pressure sores which will be very difficult to treat

Padding of the bony stumps and resurfacing the defects with large regional pedicled flaps

Grafting the secondary defects of the flap with skin if needed.

The general principles that have to be considered during designing the flaps for resurfacing include:

The flap should be designed as large as possible and in such a way so that it can be readvanced further if there is a recurrence.

The suture line should be away from the pressure points.

The flap should not encroach into another flap territory.

The choice of flap selected for reconstruction following debridement will depend on many factors like location of the pressure sore, level and severity of the spinal injury, ambulatory status history of recurrence and prior surgeries, associated medical problems, psychosocial, educational and motivational status of the patient. Options for surgical reconstruction includes skin flaps, fasciocutaneous flaps, muscle flaps, musculocutaneous flaps, perforator flaps or free flaps.^{4,8,9}

RECONSTRUCTION ACCORDING TO ANATOMIC SITES

Sacral Pressure Sores

Fasciocutaneous advancement flaps, as well as musculocutaneous flaps, are the commonest flaps used in the reconstruction of sacral pressure sores. Most of the musculocutaneous flaps planned for reconstruction are based on the gluteus maximus muscle. The gluteal flaps may be superiorly or inferiorly based, may include a part or whole of the gluteus maximus muscle. The flaps may be rotated, advanced or transposed into the defect as a muscle only or musculocutaneous or fasciocutaneous flaps. Muscle alone can be turned over to fill the cavity. Other flaps include lumbosacral flaps based on the lumbar perforating vessels.^{4,10}

Ischial Pressure Sores

Fasciocutaneous rotation advancement flaps from the thigh or gluteal region as well as musculocutaneous flaps based on the gluteus maximus muscle, hamstrings from the thigh, tensor fascia lata muscle, gracilis muscle etc are all good options for reconstruction of ischial pressure sores.

Trochanteric Pressure Sores

Trochanteric pressure sores are commonly seen in patients who lie in the lateral position, and also in patients with flexion contractures of the hip. Advancement flaps or transposition flaps based on the tensor fascia lata muscle are the commonest flaps used for reconstruction.

Complex Recurrent Multiple Pressure Sores

In patients with complex recurrent multiple pressure sores, total thigh flaps may be done, where the femur is removed and the whole of skin and soft tissues of the thigh are used to resurface the defect.

Future Trends

Modern methods of treatment like tissue expansion are also becoming popular since it has the advantage of expanding the sensate skin in an adjacent area and advancing to the insensate area. Tissue expansion is also useful in providing supple skin cover in cases of unstable scars or recurrent breakdown in the grafted skin. Another promising newer modality of treatment of pressure sore includes neurocutaneous free flaps or sensate free flaps.⁴ Yamamoto et al.¹¹ in 1992 described a free lateral thigh flap pedicled on the first and third direct cutaneous branches of the deep femoral vessels. This was used to cover a large recurrent sacral pressure sore. They also

described a free medial plantar flap was transferred to a recurrent ischial pressure sore.

CONCLUSION

Plastic surgeons have an important role to play in the rehabilitation phase of traumatic spinal cord injury patients with pressure sores. Early reconstructive surgeries for pressure sores will prevent the development of complications and provide better QOL for these patients

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REFERENCES

1. Kruger EA, Pires M, Ngann Y, Sterling M, Rubayi S. Comprehensive management of pressure ulcers in spinal cord injury: current concepts and future trends. *The journal of spinal cord medicine*. 2013 Nov 1;36(6):572-585.
2. Groth KE. Clinical observations and experimental studies of the pathogenesis of decubitus ulcers. *Acta Chir Scand*. 1942;87(76):1-209.
3. Kosiak M. Etiology of decubitus ulcers. *Archives of physical medicine and rehabilitation*. 1961 Jan;42:19.
4. Neligan PC, Song DH. editors. *Plastic Surgery 3rd edition*; Vol 4: TorontoElsevier Saunders; 2013. pp. 352-382.
5. Black JM, Edsberg LE, Baharestani MM, Langemo D, Goldberg M, McNichol L, et al. Pressure ulcers: avoidable or unavoidable? Results of the national pressure ulcer advisory panel consensus conference. *Ostomy-Wound Management*. 2011 Feb 1;57(2):24.
6. Kosiak M. Prevention and rehabilitation of pressure ulcers. *Decubitus*. 1991 May;4(2):60-62.
7. Garber SL, Rintala DH, Hart KA, Fuhrer MJ. Pressure ulcer risk in spinal cord injury: predictors of ulcer status over 3 years. *Archives of physical medicine and rehabilitation*. 2000 Apr 1;81(4):465-471.
8. Dorner B, Posthauer ME, Thomas D. The role of nutrition in pressure ulcer prevention and treatment: National Pressure Ulcer Advisory Panel white paper. *Advances in skin & wound care*. 2009 May 1;22(5):212-221.
9. Bauer J, Phillips LG. MOC-PSSM CME Article: Pressure Sores. *Plastic and Reconstructive Surgery* [Internet]. Ovid Technologies (Wolters Kluwer Health); 2008 Jan;121(MOC-PS CME Coll):1-10.
10. Regan MA, Teasell RW, Wolfe DL, Keast D, Mortenson WB, Aubut JA. Spinal Cord Injury Rehabilitation Evidence Research Team. A systematic review of therapeutic interventions for pressure ulcers after spinal cord injury. *Archives of physical medicine and rehabilitation*. 2009 Feb 1;90(2):213-231.
11. Yamamoto Y, Ohura T, Shintomi Y, Sugihara T, Nohira K, Igawa H. Superiority of the fasciocutaneous flap in reconstruction of sacral pressure sores. *Annals of plastic surgery*. 1993 Feb;30(2):116-121.