Clinical profile and management of scalp and calvarial defects at a tertiary care center in Kashmir Valley

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ABSTRACT

Introduction: The defects of the scalp and calvarium pose a potential threat to the underlying brain. These defects are common in our valley predominantly because of burns and bear mauling injuries. Bear mauling which forms the second common cause of scalp defect is rarely seen in other parts of the world.

Objective(s): Analysis of various scalp defects and their management.

Methods and materials: A total of 94 patients were included in the study from 2005-2014. Sixty four patients were in the retrospective group and thirty patients were in the prospective group.

Results: The majority of patients (37) in our series had suffered burn injuries followed by bear mauling injuries (23) and malignancy was found in 19 patients. The commonest form of reconstruction in scalp defects was grafting (62.76%) followed by flap cover (29.78%) and expanders (7.44%).

Conclusion: Scalp and calvarial defects are caused by wide variety of etiologies but bear mauling form a significant proportion of patients in our series and more than 40% (5 out of 12) of free flaps in our series were done for defects resulting from bear mauling.

Keywords: Bear mauling, Scalp defects, Scalp reconstruction

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INTRODUCTION

The most important organ of the human body, the brain, is well protected on all the sides by a bony cage. The calvarium (vault of skull) which forms the roof and the side walls of the cranial cavity is covered by the scalp. This scalp is bordered by the face anteriorly, neck posteriorly and ears on the sides. It has five layers which include skin, connective tissue, galea aponeurotica, loose areolar tissue and pericranium.

Defects may result from trauma, thermal or electrical burns, resection of benign or malignant tumors, infections, osteoradionecrosis, or congenital lesions.

Every patient with a scalp defect does not require operative intervention. Limited partial-thickness defects of the scalp

may be left to heal by secondary intention¹. However, significant contracture may result, and the scar may have limited or no hair growth. The best replacement of scalp tissue is by scalp tissue itself. This scalp tissue may be used by various means to cover these defects which include primary closure, serial excision, local flaps, tissue expanders or the scalp extender technique. Tissue, other than scalp, can be used in the form of regional flaps and even free flaps.

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Calvarial reconstruction is performed to provide protective coverage of the intracranial contents and to restore cranial contour. Autologous bone is generally preferred when possible. Autologous reconstruction typically uses either free vascularized or non-vascularized bone harvested from rib, calvarium or ilium. Alloplastic material used to repair calvarial defects includes titanium mesh, methyl methacrylate or calcium hydroxyapatite cement with each having their own advantages and disadvantages.

The defects of the scalp and calvarium are common in our valley and the majority of these defects are caused by bear mauling injuries, which is less likely to be found in other parts of the world. This prompted us to undertake a study of the cause and reconstruction of calvarial defects presented to our institute.

MATERIAL AND METHODS

The study is descriptive(retrospective/ prospective) study conducted in the Department of Burns, Plastic and Reconstructive surgery of the Sher-i-Kashmir Institute of Medical Sciences (SKIMS) Srinagar, Kashmir. The retrospective study was conducted from January 2005-April 2012 and the prospective study from May 2012 to April 2014.

In the retrospective study, the case files of the 64 patients were retrieved from the Medical Records Department by their unique identification numbers after ascertaining their identity from operation theater ledgers. All the data was collected and recorded as per the proforma approved by Institute Ethical Committee (IEC). These patients were either seen at routine follow up or contacted and then interviewed and examined.

In the prospective group, 30 patients were included in the study. All the patients were subjected to detailed history and general physical and local examination. Baseline investigations were done in all the patients and the skeletal surveys/computerized tomogram (CT) scans done as and when needed

Appropriate surgical management and reconstruction was done as needed and patients were observed postoperatively in the hospital and then in the outpatient department till the completion of their treatment

RESULTS

A total of 94 patients were included in our study. 64 patients

were in the retrospective group and 30 patients were in the prospective group. Increased incidence of patients was seen in the prospective period of our study (Table 1). Male to female ratio was 2:1 (63 males: 31 females) with no particular age preference in general (Figure 1). The majority of patients (37) in our series had suffered burn injuries (Table 2). Burns predominated in children and in the adolescent age group (21 patients), while bear mauling injuries predominated among the young and middle aged (15) patients. Malignancy of the scalp was predominantly seen in elderly people (12 patients).

Table 1: Distribution by year

Year	No. of Patients	Percentage (%)
1999	3	3.3
2000	5	5.3
2001	4	4.2
2002	5	5.3
2003	4	4.2
2004	6	6.3
2005	5	5.3
2006	5	5.3
2007	4	4.2
2008	9	9.5
2009	7	7.5
2010	6	6.3
2011	8	8.6
2012	7	7.5
2013	8	8.6
2014	8	8.6

FIGURE 1: Bar diagram showing distribution of patients as per their age

Table 2: Distribution of patients as per etiology

Etiology	No. of Patients	Percentage
Bear mauling	23	24.5
Burn	37	39.2
Road traffic accidents	8	8.5
Malignancies	19	20.3
Nevus	7	7.5
TOTAL	94	100

The scalp only was involved eighty patients, while fourteen patients had scalp with calvarial involvement. Burn was the major etiological factor in both the groups (scalp only/ scalp and calvarium: 40% and 35.7%) followed by bear mauling (23.75% and 28.57%). More than 50% of the scalp defects were $< 20\text{cm}^2$ (Table 3). Sixteen patients of malignancy had involvement of scalp only and in three patients it had penetrated deep to involve the underlying calvarium. Parietal followed by temporal scalp was predominantly involved (23 and 20 patients) and same was true about underlying calvarium (6 and 4 patients). Associated injuries were found in varied number of patients in our study as depicted in (Table 4)

A Chest x-ray was performed in all the patients as a part of the pre-anaesthetic checkup (PAC) or general workup. Rib

(either single or multiple) were seen in three patients as an associated finding. CT scan of the skull was done in all the patients with malignancy and selected patients in other groups where we suspected involvement of underlying bone or brain. The commonest form of reconstruction in scalp defects was grafting (59 patients) followed by flap cover (28 patients) and expanders (7 patients) (Figure 2). Partial graft loss occurred in three patients in our series and these were managed conservatively with dressings. Two patients with burns and one patient of road traffic accident had total graft loss which was successfully treated by re-grafting. Twelve free flap reconstructions were performed in eleven patients and eighteen local scalp flaps were done in seventeen patients with one failure in each group (Table 5). Among the local flaps, transposition flap dominated (13) followed by Orticochea flap (3) and bipedicle flaps (2). One of these eighteen local flaps had a partial necrosis (large transposition flap). This patient had sustained a bear mauling injury and had a defect of $> 100\text{cm}^2$ and thus needed a Latissimus dorsi (LD) free flap as a salvage procedure. Latissimus dorsi was the most commonly used free flap in our series (Table 6) and there was one free flap failure which needed replacement by free omentum flap.

Table 3: Distribution of scalp defects as per size

Etiology	$< 20\text{cm}^2$	$20-50\text{cm}^2$	$50-100\text{cm}^2$	$> 100\text{cm}^2$	Total
Bear Mauling	8	3	4	4	19
Burn	21	5	5	1	32
Road Traffic Accident	4	1	1	0	6
Malignancy	10	2	2	2	16
Nevus	2	4	1	0	7
Total	43	11	12	7	80

Table 4: Associated Injuries

Etiology of Defect		0	1	2	3	4	5	6
Bear Mauling	No.	23	17	10	8	12	2	1
	%	100.0	73.9	43.5	34.7	52.2	8.69	4.3
Others (ALL other categories?)	No.	14	2	5	3	5	1	2
	%	100.0	14.3	35.7	21.4	35.7	7.14	14.3

0 = Soft tissue injury; 1 = Facial fractures; 2 = Facial lacerations; 3 = Extremity fractures; 4 = Extremity lacerations; 5 = Rib fractures; 6 = Intra-abdominal injury

Figure 2: Bar chart showing management of patients in our series

Table 5: Loco regional and free flap distribution

	Local	Free Flap	Total
Bear mauling	6	5	11
Burn	8	3	11
Road traffic Accident	1	1	2
Malignancies	3	3	6
Total	18	12	30

Table 6: Free flap distribution

Etiology	Latissmus Dorsi Flap	Anterolateral thigh flap	Radial Forearm Flap	Omental free flap	Total
Bear mauling	3	1	1	0	5
Burn	0	1	1	1	3
Road traffic Accident	0	0	1	0	1
Malignancies	2	0	1	0	3
Total	5	2	4	1	12

The calvarial reconstruction was done with alloplastic material in 11 patients in our series. Polymethyl methacrylate was used (in all of them) as reconstructive material with one exposure. Autogenous bone graft from ribs was used in 3 patients in our series.

Most of the procedures were uneventful. Graft loss (partial/total) was seen in six patients. Local flap necrosis was seen in one patient and free flap failure in one patient in the immediate postoperative period and two patients had Cerebrospinal fluid (CSF) leak. During the follow up period up to six months, two patients with malignant lesions developed recurrences, and one patient with a congenital nevus had expander infection.

DISCUSSION

Scalp and calvarial defects are one of the main groups of injuries seen in Plastic and Reconstructive Surgery in Kashmir. The proper choice of a reconstructive technique is affected by several factors which include the size and location of the defect, the presence or absence of hair, location of the hairline and patient's co-morbidities. Reconstruction of complex defects due to scalp avulsion still remains a challenging problem for the reconstructive surgeon.

An average of seven to eight patients per year presenting with calvarial injury were seen during the latter part of the study compared to three to four patients earlier. This rising incidence is due to an increased occurrence of burns and bear mauling injuries during the later part of our study. Middaugh² also reported a rising trend of bear mauling injuries with time in his study and attributed it to the rising population and increase in tourism, bringing nature and humans in conflict.

Majority of the patients in our study were in the young and middle age group and this group of patients were mostly affected by bear mauling, electrical burns or vehicular accidents. Males usually go into the forests to collect fire wood and get trapped into the bear human conflicts. Electrical injuries usually occur due to inadequate use of safety measures while handling live wires³. Involvement of

young group of people was also seen by Jain et al⁴ in their study.

Our society is male dominated and their more outdoor activities make them more susceptible to bear mauling, burns and accidents. Malignancies are more common in males because most of the males do not use head covers like caps / hats while as females, even if they go outdoors, they go with their heads covered. Male predominance was also reported by many other authors³⁻⁸ again attributing it to their high level of outdoor activity.

Bear mauling and burns constitute the majority of the patients in our study (63.8%). The high incidence of bear mauling during the prospective part of the study was thought to be because of the encroachment on bear prevalent areas by humans, who were gathering fire wood and building houses near such areas. The decrease in the bear habitat area has made bears move into the human habitat in search of food and, thus, resulted in more bear-human conflicts. The scalp becomes an easy target in such conflicts as Asiatic black bears easily reach the head while standing on their hind legs and avulse the scalp with their paws/claws. High rate of flame/scald burns especially in children in our society is due to lack of proper care by parents.

The incidence of scalp and calvarial burns due to scalds and flame has, however, progressively decreased during the recent times probably because of an improvement in the socio-economic status of our population, which has resulted in conversion of the "sitting-type" kitchens to "standing-type" kitchens where children are less likely to be able to reach containers with hot liquids and food. In addition, nowadays with the routine use of geysers in kitchens and better educational status of the parents, the burn rates in the children are declining.

However, the recent increase in the incidence of electrical injuries is attributed to the widespread electricity supply to even remote areas and an increase in the number of industrial units operating on electricity, with lack of proper safety measures provided to the workers of electrical department and industrial workers in our society³. Lack of

proper safety measures, proper insulated transmission lines, and non-enforcement of strict laws for prevention of electrical burns, were reasons given by Jain et al⁴ for the high rate of electrical burns in their series.

The majority of the malignant lesions in our series were squamous cell carcinomas, as reported by many other authors,^{9, 10} mainly occurring in males. Women remain mostly indoors with their heads covered, and are less susceptible to such sun-related lesions.

Management

Eighty patients (85.1%) in our series had scalp only injuries, and 14 patients (14.9%) had scalp and calvarial involvement. The mode of reconstruction depended upon primary pathology and depth of injury. Benign scalp lesions which could result in large defects were managed by expanders before the final excision, to avoid cosmetic deformity alopecia and the rest of the patients were managed either by skin grafts or various flaps.

Partial thickness defects result when pericranium remains intact. Such defects need an immediate skin graft. Delayed skin grafting is needed in partial thickness burns only after healthy granulation tissue has grown on the wound. (Figure 3) This form of reconstruction is easy, is not time consuming and has few complications. Though there were three cases of total graft loss due to infection. They were successfully treated by re-grafting. The only disadvantage with this form of treatment is that the area has no hair growth, but can later be managed by expansion of the surrounding hair bearing scalp.

FIGURE 3: Face and Scalp grafting in a burn patient

When pericranium is lost (exposed group), exposed bone always needs a flap cover. Local flaps are the workhorses for covering the scalp defects. They are more reliable and technically easier than free micro vascular transfers. In our series, the transposition flap was the predominant local flap done (thirteen cases), especially in cases where the defect was of moderate size and limited to a single area (Figure 4). The main disadvantage of transposition flaps is the area of secondary alopecia from the donor site, which needs reconstruction by expansion of hair bearing scalp in future. Partial necrosis of one of the large transposition flaps occurred in a case of a bear mauling injury. This necrosis was attributed to the avulsion injury to the surrounding scalp by the bear with resultant thrombosis of the vessels at the base of the flap. This patient was successfully salvaged by Lattismusdorsi free muscle flap. An Orticochea procedure was done in three patients with a central scalp defect, of which two were caused by bear mauling and one by an electrical burn, while a bipedicled flap was done in two patients with small occipital defects.

FIGURE 4: Left parieto-occipital squamous cell malignancy

Micro vascular free tissue transfer for scalp reconstruction is a vital form of reconstruction especially indicated when the defect is either too large for local flap cover, the surrounding tissue is extensively injured, post malignancy excision requiring postoperative radiotherapy or even when extensive forehead reconstruction is needed. Different free flaps have been used depending upon the site, size and etiology of the defect, condition of underlying bone and

overall condition of the patient¹¹⁻¹⁴. We did twelve free flaps in eleven patients in our series. Free flaps were done as a primary procedure in ten patients while in two patients they were used as a salvage procedure. There was loss of one of the free flaps on the second postoperative day because of venous thrombosis. This needed a second free flap (omentum) to cover the defect after two attempts of re-exploration failed to salvage the original flap. Another patient needed a LD free flap as a salvage procedure when there was partial flap necrosis of the large transposition flap in a patient who had been mauled by a bear.

The Anterolateral (Alt) thigh flap was our preferred free flap choice during the initial period of the study. Advantages of the ALT is its large size and thin nature with the additional advantage of the possibility of harvesting it simultaneously with preparation of the recipient site, without changing the position of the patient.

LD flap was used as a primary procedure in four patients and as a salvage procedure in one patient. The long vascular pedicle makes it easier for the anastomosis to be performed even in the neck. Because of such advantages, LD has been used by many authors for scalp reconstruction^{10, 12, 15, 16}.

The free Radial forearm flap was used in four patients. All these four patients had involvement of a portion of the forehead and thus needed thin hairless and cosmetically acceptable flap cover (Fig 5). Sweeny et al¹³ used the free radial forearm flap in 34% patients in their series because of its advantages such as ease of harvest, reliable vascularity and low donor site morbidity. They used this flap especially for frontal and temporal defects or when the defects were less than 7cm. Out of 30 cases, Lutz et al¹¹ performed 15 free radial forearm flaps for defects of varied etiology because it was the localization rather than size of defect that was the deciding factor.

FIGURE 5: Showing post bear maul scalp and forehead defect covered by radial forearm free flap.

The free greater omentum flap is usually used as a salvage procedure.¹⁷ In a case of exposed calvarium, (after a failed free ALT flap), a free omental flap was performed.

Expansion of the hair bearing scalp is done for cosmetic reasons so that an area of scalp alopecia or a grafted area over the calvarium is replaced by hair bearing tissue. In addition, expanders can be put adjacent to benign scalp lesions prior to their excision so that expanded scalp can be used to cover the defect created after their excision in the same operation. Expanders were used only in patients with congenital nevi. Seven patients with nevi were treated with expanders and there was infection in only one case. However, this infection responded well to injectable antibiotics. The nevi were excised 14-16 weeks after expander insertion and the resultant defect covered by expanded flaps. A resultant standing cone deformity needed correction in two patients.

Both scalp and calvaria were involved in fourteen patients and majority of these were either electrical burns or bear mauling injuries, but three patients had ulcerative /ulceroproliferative growths with involvement of the cranium and needed resection of bone.

All these patients needed a staged reconstruction. First the soft tissue cover was provided and after it was completely stable and supple, a cranioplasty was done. In malignancies, a mean duration of eighteen months was needed between the two procedures till sure of no recurrent disease, while in cases of non-malignant nature, the second procedure was done after four to six months. Soft tissue cover was provided by local transposition flaps in twelve and free flaps in two patients. Autologous cranioplasty was done in three patients (split rib grafts in two and iliac bone grafts in one patient). Alloplastic material as polymethyl methacrylate was used in eleven patients with one exposure. The exposed polymethylmethacrylate was removed and the wound settled. This patient was later lost to follow up. We preferred to perform alloplastic cranioplasty because of the short operative time, absent donor site morbidity and low exposure rate in our setup.

COMPLICATIONS

Most of the procedures went uneventful. Graft loss (partial/total) was seen in six patients. Three of these had partial loss and were managed conservatively with regular dressing and antibiotics whereas another three patients suffered total graft loss due to infection and needed revision grafting after proper preparation of the wound bed. Local flap necrosis was seen in one patient and was salvaged by a free LD flap, while one free flap failure was managed by a free omental flap. Two patients developed cerebrospinal fluid (CSF) leak in the immediate postoperative period, of which one was conservatively managed (Diamox), but the other patient later required operative intervention with a duraplasty. Expander infection was seen in one patient who responded well to antibiotics.

CONCLUSION

Scalp and calvarial defects are caused by wide variety of etiologies but bear mauling injuries form a significant proportion of patients in our series and more than 40% of free flaps in our series were done for these post bear mauling defects. This seems to be one of the major differences between the management of bear mauling injuries and others, as most of the times a small defect created by bear mauling injury needs a free flap cover because the surrounding scalp area is also affected by multiple lacerations and, thus, making it not amenable for any local tissue transfer.

DECLARATIONS

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Written informed consent: Written informed consent was sought from all the enrolled patients for data as well as their images/pictures.

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