Roopkund Mystery "Pathology Reveals Head Injury behind the Casualties"

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Abstract: *This paper attempts to reveal the death mystery of Roopkund victims through the pathological investigation. The Skeletal material for the study has been collected from the site. Investigations have been performed according to the standard suggested in "The Data collection Codebook" (The Global History of Health Project). Basic methods, such as observation and non-metric analysis have been used to know the victim's personal information's (Sex, Age), health status and the most important, cause or causes of this mass casualty. Skull pathologies are categorized in terms of trauma (fractures/wound/ dislocation/cut-marks), infection/deficiency, new bone formation and the severity of the pathological findings are graded as per the International Grading System (Global History of Health Project) for the problem. All observed features and problems are neatly displayed in the result section. Identified pathologies and cause of the problem have been displayed one by one in the discussion section. On the basis of all supposed causes which are discussed in above sections the final comment on the death of victims is given in the conclusion section.*

Keywords: Roopkund, Skull, Pathology, Trauma, Head Injury, Porosity, Cribra Orbitelia

Introduction

Roopkund is a small bowl shaped beautiful glacial lake, situated on the upper Himalayan region of the Uttarakhand State, in India, at the altitude of 5029mt. the lake is surrounded by the magnificent peaks of Nanda Ghungti and Trishul Massif from the north eastern side. The area is uninhabited and evens the last village of the valley named Wan, is more than 30 km far from the lake and it takes 3 days walk to reach the base camp. The weather conditions of the area is too sensitive and vary with the altitude and almost 10 months in a year it is covered by snow, only August and September months are appropriate for tourist visits. Many rare Himalayan flowers like Saussurea obvallata, Saussurea simpsoniana, Saussurea piptathera, Saussurea gosifipora, Cryptogramma crispa, Rihum etc. are usually seen here. Roopkund has a religious importance among the locals and in the past it was known as the 'Rudrakund', but discovery of human skeletal remains at the lake side in 1938, gave it international fame and sometimes named as Mystery Lake, Skeletal Lake by the people. Nobody knows that why and how these people had reached here and what happened to them? After the discovery of these remains, a number of expeditions and investigations to know the personal identity,

origin of the people and cause of this mass casualty has been conducted by many national and international institutions but none of them could give a conclusion on the mysterious remains present at this Frozen Himalayan Lake.

Materials and Methods

For the study, skeletal material has been collected from the lake side. A total of 27 skull remains (skulls, cranium and skull fragment) have been examined under the study. Firstly, the collected material have been cleaned with the normal water and kept to dry in shade. Then all related fragments were fixed up with the associated skull or part of the bone with the help of adhesives. In that time, some skull fragments were not attached with that skull or bone from the collected bones. This was so because they were representing other individuals.

Mainly Age and sex for personal identity and pathological observation (Table 1) is conducted to know the health status and cause of the individual's death through the methods suggested by Bass (1981) and Ubelaker and Buikstra (1994).

Most of the skulls didn't have facial portion, so, cranial suture closer method and parameters (Borthwell (1981), Olivier (1969), Stewart (1979), Bass (1981) and Ubelaker and Buikstra (1994)) were used for the individual's age estimation. But the suture closer rate varies from person to person and affects the age estimation. So the accurate age assessment has been done by the examination of suture closer status, texture/ morphology, robustness, fusion of basi-occipital to basi sphenoid and extension of sphenoid sinus into occipital bone. Estimated ages have been categorized into Young adult (20-34 years), Middle age adult (35-49 years) and Old adult (50+years).

Sex determination of the individuals was determined by the observation made under the methods and parameter made by (Borthwell (1981), Olivier (1969), Stewart (1979) and Ubelaker and Buikstra (1994)) for the skull features. Features like nuctal crest, mastoid process**,** supra-orbital margin, prominence of glabella, mental eminence, gonial angle of mandible, slope of forehead, and prominence of temporal line have been examined for the sex determination. Pathological observations have been examined under the guidelines of Ubelaker and Buikstra (1994) and GHP (Global Health Project). All found pathologies are categorized in terms of trauma (fractures/wound/cut marks), porosity (infection/deficiency) and the severity of the pathological findings are graded as per the international grading system for the problem.

Result

There is, within 27 samples, 1 individual (3.7%) who has been found confirmed as young adult (20-35), 10 people (37.3%) belonged to middle age (35-49) and 6 people (22.2%) to old aged (50+) and another 6 people (22.2%) found belong to adult age group. 4 specimens (14.8%) were not suitable for age estimation. Sex determination through the skull and skull fragments was really a tough task in this study, because only two specimens had maximum feature for observation.

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Table 1: Age, Sex and Pathological Description of Roopkund Cranial Remains

Sl. No.	Sp. No.	Age	Sex	Affected Areas	Problem			Remarks
					Porosity/ Infection	Trauma	New Bone/ Osteoblast/ Bone Growth	
1	RCA II	45	F	Frontal bone, left Orbit	-	Wound marks	Spine kind of growth in left orbit	Morphological
2	RCA IV	45	PM	Vertex / along the lamboid suture, Left side of frontal bone	P (2)	Anti – mortem Fracture	-	Fracture and non specific infection due Iron and vitamin C,D deficiency
3	RCA V	45	PF	Roof of right orbit, vertex	P (3) cribra orbitalia)	Depression	-	Morphology and Iron and vitamin C,D deficiency
4	RCA VI	40	PM	Along the saggital suture, on the parietal bone, near the temporal line	P (3)	-	-	Non specific infection or Iron and vitamin C,D deficiency
5	RCA VII	50+	CD	Across the sagittal suture / both parietal	P (3)	Completely Healed fracture	-	Anti mortem fracture and Non specific infection or Iron and vitamin C,D deficiency
6	RCA VIII	40-45	CD	Left and right Parietal, occipital	?	Anti mortem crack/ swelling/ depression	Nod kind of bone growth	Crack is may be cause of death nod is osteomata and non specific infection or Iron and vitamin C,D deficiency
7	RCA XII	MA A	CD	Vertex/along sagittal and lamboid sutures, near the obelion	P (3)	Anti mortem fracture	-	Fracture is may be cause of death, Non specific infection or Iron and vitamin C,D deficiency

Figure 1: Sp. No. RCA VIII, Porosity along the Sutural Surface on Parietal Bone

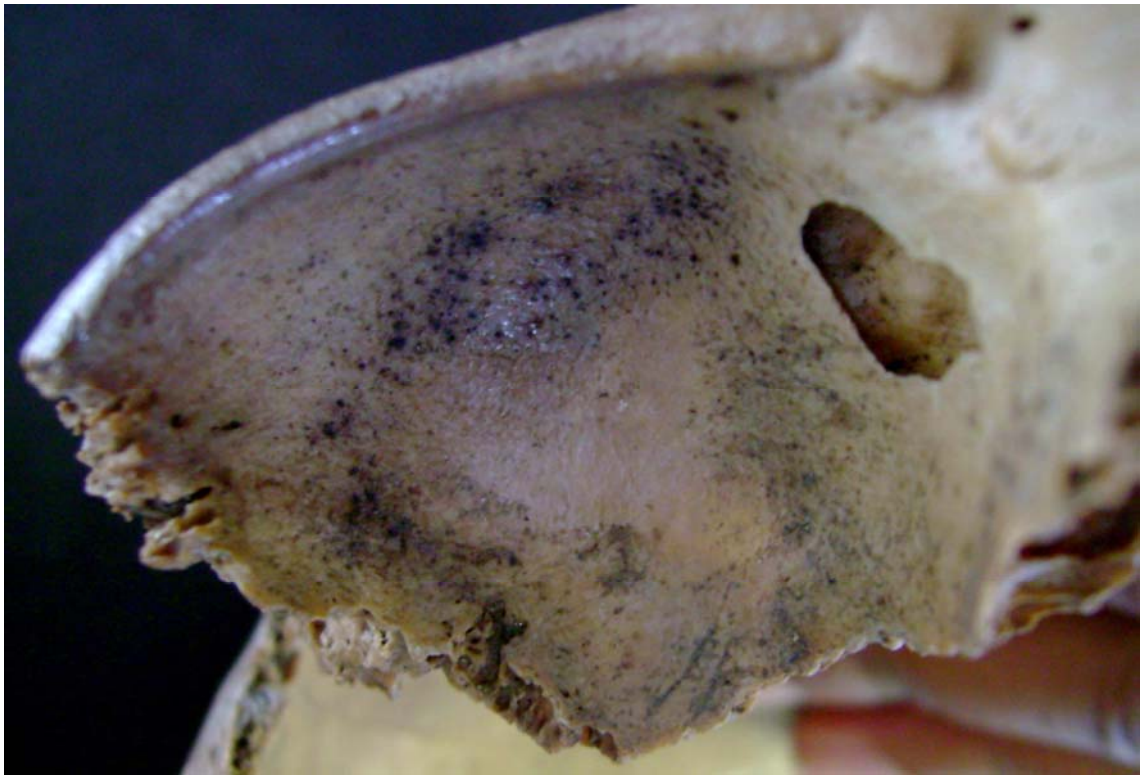

Figure 2: Sp. No: RCA V, Cribra Orbitelia at Orbit Wall- Grade 3

Figure 3: Sp. No: RCA IV, Ante Mortem Compressed Fracture

Figure 4: Sp. No. RCA VI, Post Mortem Cracks near Vertex

Figure 5: Sp. No: RCAVII, Healed Fracture across Sagittal Suture at Parietal Bones

Figure 6: Sp. No: RCA II, Wound Marks at the Frontal Bone

Figure 7: Sp. No: RCAII, Wormian (inca) Bones at the Lamboid Suture

The study revealed Male - 1 (3.7%), Female - 1 (3.7%), probably female - 5 (18.5%) and probably male - 4 (14.81%). Remains of 16 (59.5%) individuals, wasn't helpful in sex identification. There are more than 20 skull samples having pathological findings, in which, almost 16 of the individuals suffered from the porosity along the sagittal suture and at the parietal bone near the vertex. In some remains, porosity is also found at the frontal and occipital bone and inner surface of the bone. The severity of the problem is graded 3 on 9 samples, 2 on 5 samples and 1 on 2 samples.

Porosity (grade 1-3) at the orbital wall has been also found on the skull RCA III, RCA V and RCA XXIV. This orbital porosity is known as Cribra Orbtalia.

Figure 8: Sp. No. RCA VIII, Depression near the Vertex

A completely healed ante mortem fracture also found across the sagittal sutures at the middle of parietal bone of RCA VII. There are three samples RCA IV (Age 45) and RCA VIII (Age 40-45) also having Ante mortem fracture or injury on the parietal bone. These injuries can be described as 'compression fractures' which are caused by excessive impaction. Broken parts are still attached with the bone.

Besides it, RCA I is having 4x3 cm hole at the right parietal. This may be a post mortem but final comment will be placed on discussion section. A crack also appears near the suture at parietal bone of RCA IV which is looking like a post mortem. Wound marks were also found at the RCA II, these are definitely Ante mortem and will be discussed in next section. Depression was also found at the vertex and parietal bone of RCAVIII. Morphological changes in form of nod and swelling have been found on the parietal surface of some individuals. Other anomalies like wormian bones (extra bones) also present along the lambdoid suture of the some individuals.

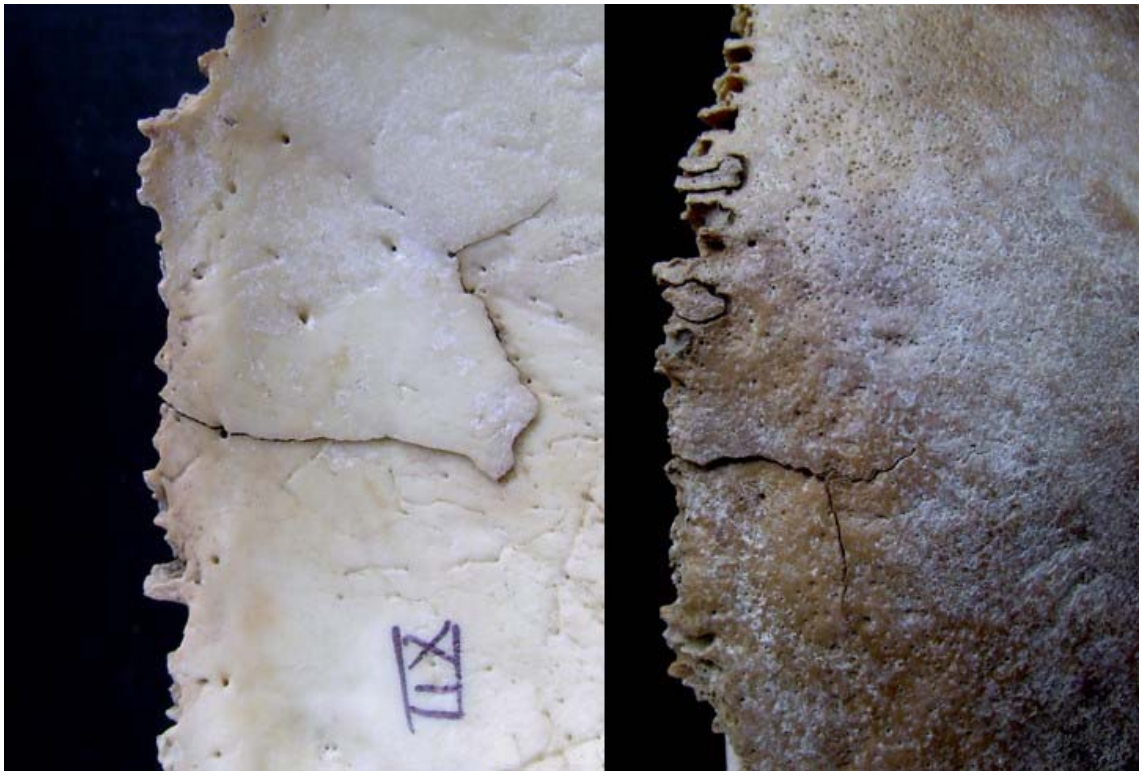

Figure 9: Sp. No RCA XII, Depressed Fracture near Sagittal Suture on Parietal Bone

Discussion

Pathological observation disclosed the severe porosity on most of the skull remains especially at the sutural side (Figure 1) and on the parietal bone near the vertex. This kind of porosity appears when a person is facing nutritional deficiency for a long time (Iron and Vitamin C, D deficiency) *(Ortner 1975; Hill 1985; Buikstra and Ubelaker 1994).* Anemia always caused by hemoglobin deficiency of vit. C and D for a long duration.

Cribra orbitalia (Figure 2) is again the result of metabolic deficiency (Iron and Vitamin C, D) *(Buikstra and Ubelaker 1994)*. But this is definitely not a reason of these individuals death because it is present in initial form and not much serious. It could have been a short term lack of Iron and Vitamin C, D, which these people has been faced during their prolonged journey towards the Roopkund (At present Roopkund stands at altitude of 5000mt. Most of the time the lake is completely enclosed by the snow and only few months are available to access the remains. So, unavailability of fresh food and proper sunlight always has been a big problem for travelers in this area).

Here it is noticeable that till today, Roopkund track covers approximately 45 km from the last bus stop and it takes 3 to 4 days to reach the lake from the last village of the valley. This track covers the altitude from 1000 to 5000mt of Himalaya. So, seeing today's geographical and environmental toughness of the Roopkund area, we can speculate the tough geographical conditions of thousands of years ago. Another most important pathology which is observed during the sample examination is fracture. Completely healed fracture of (Figure 5) RCA VII is definitely an ante mortem incident, what he

would had faced in his life; and as we see it is completely healed, it means that this individual has survived for a long time after this accident. So, it indicates that the fracture was definitely not a cause of this individual's death during his Roopkund visit. Injury and fractures of RCA IV (Figure 3) and RCA XII (Figure 9) mostly appears ante mortem and associated broken parts of the bone are still attached. This fracture technically called depressed fracture. It is assumed to have occurred by striking a heavy and round object on the head, when the skin was present on the head surface and the brain still intact inside the skull. These fractures are mostly present on the frontal and parietal bones indicating that when the incident had happened, the victims were alive and may be in standing or sitting in position.

Wound marks of RCA II (Figure 6) are ante-mortem, which she may have got during her life time. Crack of RCA VI is more appearing post mortem (Figure 4) which may have occurred after the long tremble during the landslide in Roopkund.

Depression of the RCA VIII (Figure 8) seems more morphological or may be even occupational. This kind of depression mostly occurs when people do work which involves carrying weight through a head rope on their back. This kind of technique is seen among the labors of the hilly areas of Uttarakhand and more common among the labor of tea gardens.

Other anomalies like nod and swelling are not seen in any kind of pathology; it may be a morphological feature. But high prevalence of inter-sutural extra bones is very surprising and definitely not co-incidental.

Several pedigree studies have been undertaken (Chambellan 1883 in Parker 1905:11; Barry and Barry 1967 and Finkel 1976 in O'Loughlin 2004:1), which suggest that Inca or wormian bones (Figure 7) are inherited as a dominant trait with a penetrance of around 50%. In this way, we can say that there were some victims who would have had blood relations with one another or were family members or may have been from the same community.

Conclusion

After the investigation and examination of the Roopkund remains, we have found some very important pathologies and morphology. All findings, pathology, problem and their more reliable causes have been discussed in detail at the discussion section. Below is a final comment on the findings and gives a more logical judgment on the death mystery of Roopkund victims.

Skeletal porosity (cribra orbitalia and porotic hyperostosis) seems to be the result of short term deficiency of Iron and vitamin C and D which has been occur these victims during their long Himalaya journey and which unfortunately ended at this beautiful Roopkund frozen lake. But this porosity does not have that kind of seriousness which would have been a cause of the victim's death. Completely healed ante-mortem fracture and post mortem cracks also do not seem to be the cause of unexpected death of these victims.

Wormions bone presence shows a close genetic relationship among some of these victims.

But an unhealed injury or ante mortem fracture (depressed fracture) on the parietal of victims seems to be the single and genuine cause of victims' death. After examination of the severity of the head injury it is assumed that first the fracture and thereafter excess bleeding would have become the reason of these individuals' sudden deaths. Here we are not saying that the person had died suddenly after being injured. But it could be a possibility that after this sudden injury; the victim fell unconscious and due to the lack of first-aid and cold weather, people became victims of hypothermia, which finally became the cause of death of Roopkund victims.

As concluding remark, it can be mentioned that an important case study and observation may lead to specific reasons for the mass death of individuals at Roopkund. Therein lays scope for an explorative & extensive research work for the future.

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