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Mountain Disaster Incidents and Corresponding Emergency Rescue Measures

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Abstract

Mountain rescue is a new topic emerged after the expansion of emergency rescue function of public security fire force. This paper introduces the classification of mountain disaster incidents, analyzes mountain incidents rescue features. For Police Fire fighting Army which is the professional force and key contingent of emergency rescue, the measures of emergency rescue and the equipments used in mountain disaster incidents are presented, with the aim of offering reference for the implement of the most effective and best rescue measures in similar incidents in future.

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Keywords: mountain, mountain incidents, emergency rescue

1. Introduction

China has vast lands. It is a mountainous country. There are totally 9 peaks over 8,000 meters high, and more than 150 high peaks over 7,000 meters at the borders and in the territory. Because of the curiosity to nature, more and more groups of people are coming into the mountainous areas for exploration and research work. In recent years, incidents in mountains frequently occur in outdoor sports. And the number of incidents is on the rise. According to regulations of "Fire Protection Law of the People's Republic of China", public security fire protection force, as backbone team of professional force for emergency rescue, should actively participate in the rescue work for human life, in addition to the mission of fire extinguishing. Mountain rescue is a new topic come from the expansion emergency rescue function of public security fire protection force. This paper shows three aspects of mountain disaster incidents, including rescue features, rescue equipments, rescue procedures, then, discusses the issue of mountain incidents rescue, and offers reference for the implement of the most effective and best rescue measures for similar incidents in future.

2. Mountain Disaster Incidents and Rescue Features

2.1 Classification of Mountain Disaster Incidents

Mountain incidents refer to unexpected loss or disaster in mountainous areas. There are mainly two types, namely, objective disasters, and subjective disasters [1].

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(1) Objective disasters, also known as natural disasters, refer to unexpected loss caused by objective factors in nature. For example, disaster incidents caused by natural irresistible destruction such as sudden floods, avalanches, landslides, mudslides, falling rocks, storms, and lightning. Natural disasters in mountainous areas may happen in instant, damaging farms, burying houses, destructing various facilities, and even destroying the entire village and the mountain. It is hard for people in such disastrous areas to escape. Heavy casualties and property loss may incur. On April 14, 2010, an earthquake reaching 7.1 on the Richter scale that hit the town of Jiegu located in Yushu Tibetan Autonomous Prefecture in southern Qinghai Province in Northwest China, at 7:49 am [2]. The latest report from the Xinhua News Agency, 2698 people have been confirmed dead, 70 missing and 12135 injured of which 1434 were severely injured as a result of powerful earthquake. The housings of the local residents are constructed imply, and mostly of wood-earth construction, instead of brick and cement, with the result that more than 90% of the houses in Jiegu, a town of 100 000 people nearest the epicenter, were destroyed (Fig.1), result in a heavy casualty.

(a)  (b) 

Fig. 1. Jiegu Town, before (a) and after (b) Yushu Earthquake.

(2) Subjective disasters, also known as man-made disasters, refer to unexpected loss caused by subjective factors. For example, when people are climbing mountains, climbing rocks, exploring caves, picking Chinese yams, working, and camping in dangerous mountainous areas and zones, or under bad weather and meteorological conditions, they may get lost, lose contact with the outside world, fall down cliffs, be hit by stones, cut off from water and food, attacked by animals or be trapped in traffic accidents, and therefore result in man-made disasters such as missing persons, trauma, shock, fractures, poisoning, illness and even death.

2.2 Mountain Disaster Incidents Rescue Features

In general, mountain rescue mainly has below features:

(1) Rescue timeline is urgent. Mountain rescue is a work with high demand on time. Mountain disasters would expand with time goes by, and accordingly, the number of casualties increases. Hence, once receiving disaster condition report, alarmed personnel or scheduling commander has to quickly record the site of disaster, and sent out dispatch command. Receiving command, rescue team members have to start off immediately. The driver should choose the most optimized route to get to the site. Upon arrival, the commander needs to organize disaster on site scout speedily, look for insiders to get to know how the disaster happened, where the trapped people are, their status of survival, and give instructions for rescue. Rescue team members then act according to the commander's instruction, execute rescue plan, and save the people trapped in the fastest, most accurate and secure way.

(2) The distance is long, and it is hard to reach the site. Mountain rescue mostly occur in remote areas where there are few communication tools, and away from public security fire protection force. It will take some time to get the conditions after receiving alarm. There are always no roads for vehicles to access the incident site. In most case, it all depends on walking, and even climbing. Consequently, it is hard and it takes a bit long time to get to rescue site [3].

(3) The terrain is complex, and it is hard to rescue. As the terrain in mountainous areas are full of gullies, the altitude is high and the slopes are steep, it is not easy to locate the correct site of incident and get to know the condition of the targets in a timely manner. At night, in particular, visibility is low. It's more difficult to find the people in dangers in the comparatively short time. This makes mountain rescue operations even more difficult. At the same time, mountain incident sites are constantly accompanied with dangerous conditions such as explosions, rolling stones, avalanches, landslides, floods, and thunderstorms. Rescue team cannot accurately predict danger during the rescue operations. For example, in Yushu, the rescue has been more difficult to carry out. Unlike Wenchuan in Sichuan or other

earthquakes areas in the plains, Yushu is located in a remote and backward area of Qinghai-Tibet plateau. Relief operations face massive difficulties, including severe weather, coldness, and altitude hypoxia. The quake areas are at a mean altitude of 4000m (elevation from 3750m to some villages above 4878m) [4]. The barometric pressure is about 416~462 mmHg with a lower barometric oxygen pressure of 87~97 mmHg, which are equal to 61% or near 50% of the barometric oxygen pressure at sea level. Thereby altitude hypoxia is an enormous challenge in mountain rescue operation. Secondly, at such a high elevation, the temperatures are below freezing, and the average daily temperature is -4.3℃; overnight temperatures fall to -15℃~-12℃ at Jiegu Town in spring. Freezing weather and cold have all made the rescue efforts difficult, and is a unique challenge to mountain emergency.

(4) Communication is not smooth. It is hard to coordinate and command. Once rescue team members of public security fire protection force enter the mountains, they are trapped in a zone where radio waves cannot be received. This makes communication, contact, and assistance works more difficult. It's hard to know the level of injury and the status of illness of the people in trap. Due to some complex factors at incident site, rescue team members can hardly contact the trapped people rescued, leading to delayed emergency treatment. As the unable contact in time, injured people have to be taken from incident site to safe zone with stretcher. If it takes long, the condition of the injured may worsen.

3. Conventional Equipments for Mountain Rescue

In mountain rescue operations, high performance equipments are important conditions for successful rescue. According to onsite treatment needs, equipments such as helicopters, aircraft, fire ladder trucks, rescue vehicles, ski boats, detection instrument may sometimes be used in addition to ropes, and climbing devices. Conventional equipments, based on performance and use scope, are classified into four types of rope, traction, ring hook, and transport [5].

3.1. Rope Equipments

Rope equipments, as conventional equipment for mountain rescue, include ropes (Fig. 2), safety belts(Fig. 3), hammocks, etc. are often used for self protection, supporting point formation, and transport of the wounded.

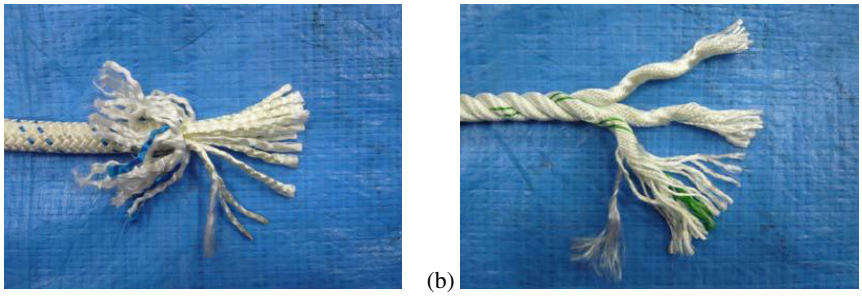

Fig. 2. Two types of ropes: (a) kernmantel rope and (b) Spiral rope

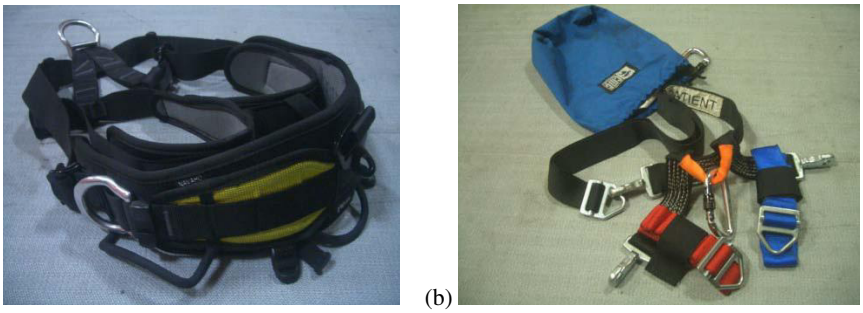

Fig. 3. The safety belts of (a) seat harness and (b) the rescued belts

3.2. Traction Equipments

Traction equipments mainly include hoists, winches, etc. and applied in operations of setting supporting point, hoist, placing rescue equipments and personnel, and rope horizontal stretching in situations when people or vehicles fall down cliffs, and people are trapped in mountainous area (separated by valley).

3.3. Ring Hook Equipments

Ring hook equipments, as auxiliary equipments for mountain rescue operations, include ascenders(Fig.4(a)), descenders, protection devices, connection devices, rollers, safety hooks(Fig.4(a)), etc. They are generally applied in climbing, descending, protection, and connection.

(a)  (b) 

Fig. 4. The hand ascender (a) and the type "D" safety hooks(b).

3.4. Transport Equipment

Transport equipments include stretchers, rope emission guns, and are used in transporting equipments and the wounded.

4. Basic Procedures of Mountain Rescue

4.1. Receiving Alarm and Scheduling

Mountain rescue is like other rescues. On receiving alarm, rescue team members must act on short notice. The following points are to be noted on receiving alarm:

(1)Accurately get to know the site of mountain incident, and brief situation of the incident. On receiving alarm, site must be determined. At the same time, get to know the brief situation of the incident. If such contents are not determined, and rescue team is dispatched blindly, rescue team members may have unstable psychology. And even, they may take equipments irrelevant to rescue.

(2) Rationally choose clothing for mountain rescue operation. Before dispatch, geographical environment and climate of the mountain disaster site must be taken into account. Wear appropriate clothing for rescue. If clothing is not appropriate, it may affect the correction implementation of rescue operation, and cause damage to rescue team members.

(3) Accurately judge onsite situation of the disaster incident, draft out rescue plan and choose necessary equipments. Based on alarm contents, we should predict the geographical situation, climate, and land or building usage of the disaster incident site. On the basis of the perspective of developing rescue operation, judgment on disaster site, operation obstacles, and level of dangerousness should be made. Depending on the information known around the incident site, climate and time, get prepared psychologically for rescue operation, choose rescue method and necessary equipments. Multiple rescue plans can be set.

4.2. Dispatch

Safely and quickly get to disaster incident site is necessary for mission execution. Rescue team members should pay attention to points below when dispatch: (1) On receiving dispatch command, do things in order to avoid collision, and collapse. (2) Avoid equipment from falling. When dispatch, in particular, make sure whether the equipment chosen are sufficient, and whether the equipments door of the vehicle is shut off.

On the way of dispatch, pay attention to points below: (1) Utilize vehicle-mounted communication equipment to keep in contact with scheduling command center. Keep abreast of developments and changes of the incident at all times. Make request for reinforcements and assistance from relevant departments according to needs. (2) On the way, pay attention to traffic safety, to prevent traffic accidents.

4.3. On Site Information Collection and Grasp

First, check out the position, time, and danger situation of the people in distress at short notice. Second, inquire insiders, to get to know the name, age, gender, physical condition of the people in distress, and whether he is injured or ill. Third, find ways for rescue, whether there are obstacles between where the people in distress are to land. Figure out the conditions of surrounding lands, topography, and trees, and whether there is place for fixing rescue equipments.

4.4. Alert and Evacuation

First, delimit warning zone, set warning line, and evacuate crowds. Second, park vehicle at safe and reliable position that is convenient for command, and rescue.

4.5. Determination on Rescue Method

Commonly, mountain incidents are very different from fire accident. Once the commander reaches the site, he has to remain calm, and determine rescue plan based on terrain, surface features, number of people in need of rescue, insecure conditions, and equipments of rescue team, and figure out ways to correctly, safely, and quickly rescue those in danger [6]. On allocating tasks, rescue forces should be arranged rationally. Full consideration should be taken upon the ability of team members and the actual situation onsite. Rescue method, and choice of rescue equipments, in particular, hesitation must be avoided to avoid causing misunderstanding or inability to comprehend the purpose of the commander, which may result in loss of best chance and initiative for conducting correct operation. Fig.5 (a) and (b) show the “Octopus” Fixation System, which making the pivots by the terrain and surface features. Trees, rocks, soil-bag and so on can be used to make the pivots. In mountain rescue, the rescuer can use many steel ropes and pulleys to constitute the clip mechanism. Fig.6 (a) and (b) show the “rope pulley traction technology”. The heavy weights can be pulled by the several times of the traction force, for example, 3 times force traction, 5 times force traction, 9 times force traction and so on.

Fig. 5. The “Octopus” Fixation System

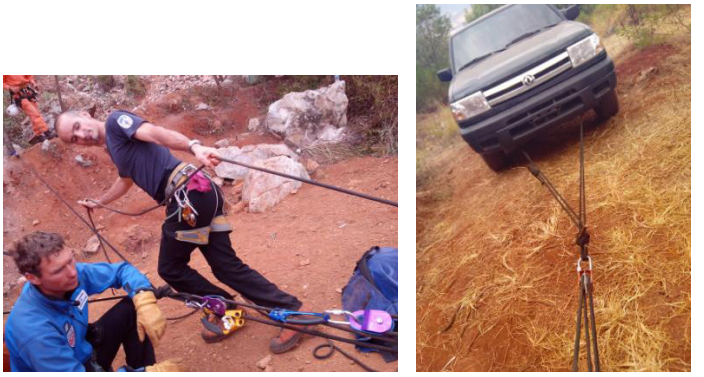

Fig. 6. The “rope pulley traction technology”

4.6. Development of Rescue Operations

First, in rescue operation, keep contact with those to be rescued at all times. Grasp the situation, and request those to be rescued to cooperate in rescue operation. Second, rescue team members should utilize climbing, rock climbing equipments to conduct ascending or gliding rescue. Members need to coordinate with each other. Third, if the number of people to be rescued is big, and the situation is that if they are able to rescue themselves by reaching object for moving up or down, rescue team can fix secure rope for them for self rescue. Fourth, if the people in distress are injured or cannot move, use multi-function stretcher or body fix gasbag to fix it, conduct first aid, and then transport to hospital for treatment immediately. Fifth, organize coordinated operations. Rescue teams often take actions by single team. In big or severe disaster incidents, there may be several rescue teams reaching onsite at the same time. All rescue teams participate in rescue operation, listen to the unified command from command center, determine on cooperation method, start time, and operation scope, and then taken actions on their own. Each team commander, should summon their team member, pass down rescue instructions, allocate tasks for each member, and then point out precautions. Sixth, guarantee logistics in place. As time, environment, and climate conditions are uncertain, commander and command organs should organize various guarantees (supplies, ambulance, lighting, etc.) depending on changes of all types of factors, so that rescue teams can retain combat effectiveness and sustaining time to ensure successful completion of rescue mission.

4.7. Acute altitude illness in rescuers at the high altitude areas

It is difficult to work for rescuers who not previously acclimatized to the high altitude. Generally, helicopters were not used in some mountain rescue due to inclement weather and windstorm. In such remote areas away from medical resources, descent was not feasible due to terrain, so patients with high altitude pulmonary edema were treated promptly by bed rest, supplemental oxygen or a portable hyperbaric chamber (pressure bag) and with dexamethasone and/or nifedipine, as the first therapy step before evacuation. After admission to the hospital, treatment would be focused on oxygen administration, by the use of pulmonary vasodilators, dexamethasone, and diuretics.

4.8 The effects of cardiopulmonary resuscitation (CPR) at high altitudes on the physical condition of rescuers

A growing number of persons with cardiovascular diseases are ascending to high altitude. Immediate CPR is required for patients with cardiac arrest. Although performing CPR is effort intensive at sea level, performing CPR at high altitude is even more exhausting. Hajime Narahara experienced a case of prolonged CPR on Mount Fuji (3776m) that demanded strenuous work by the rescuers [7]. The effects of CPR at 2700m and 3700m above sea level on the physical condition of the rescuers were studied in 8 male volunteers. The results showed that the CPR for 5 minutes at 3700m significantly reduced arterial blood oxygen saturation and increased rate-pressure products. Scores on the Borg scale, a subjective score of fatigue, after CPR action at 2700m and 3700m were higher than the scores at sea level. We get the conclusions that prolonged CPR at high altitude exerts a significant physical effect upon the condition of rescuers. The use of equipment such as portable automated external defibrillators, chest balloon pressure, and mechanical chest compression devices should be considered to reduce the workload of CPR on rescuers working at high altitudes.

4.9. On Site Cleanup

Once rescue mission is completed, count the number of people, sort out equipments, make records, and evacuate safely.

5. Conclusion

Mountain emergency rescue is a new hot issue and new topic for public security fire protection force facing at present. It is a tough mission inevitably confronted with social development. To safely, accurately, speedily, and effectively implement rescue operations, fire protection forces have to depend on emergency command center, carry out unified leadership, unified command, and graded responsibilities, base on the professional advantages, equipment advantages, and technical advantages of various rescue forces, conduct scientific on site control and clear division of labor, shorten start-up time, grasp winning opportunities, form strong fighting force, and guarantee the completion of emergency rescue missions.

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