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APPLICATION OF MOTION CAPTURE TECHNOLOGY IN BIOMECHANICAL RESEARCH OF MASSAGE TECHNIQUES

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Abstract: Massage manipulation is a commonly used clinical treatment method, but there is a lack of simple, intuitive, and highly visual research methods. There are various forms of operation of the same technique, with varying effects. Motion capture technology can track the motion trajectory of marked objects in three-dimensional space, and analyze their motion patterns by collecting, recording, and measuring the kinematic and biomechanical parameters of the objects. The emergence of this technology makes it possible to quantify factors such as the size, direction, time, and speed of force in manual operations. It also makes the research on massage techniques shift from subjectivity and experience to standardization, visualization, and objectification, and becomes the basis for massage techniques. It has laid an extremely important foundation for its clinical promotion and inheritance.
Keywords: Massage; Manipulation, Orthopedics; Motion capture technology; Biomechanics

1 OVERVIEW OF MOTION CAPTURE TECHNOLOGY

The human body is a complex and delicate system, with a level of sophistication and coordination unmatched by any other biological machinery. This also makes it extremely difficult to obtain human body motion parameters. With the advancement of science and technology, biomechanical technology is used to study detailed mechanical information during human movement or movement, and combining experimental measurements with theory makes it relatively simple to obtain various movement parameters of the human body. Motion capture technology, also known as motion capture technology in China, refers to a process of recording biological motion by tracking the motion of some key points in the time domain, and then converting it into a usable mathematical expression and synthesizing a separate 3D motion [1]. Motion capture technology has been widely used in biomechanical research on the physiology and pathology of human skeleton and other systems. Massage manipulation is one of the commonly used and effective clinical treatment methods. However, many of these manipulations lack simple, intuitive, and highly visual research methods. Most clinicians only rely on personal experience to grasp the direction, intensity, time and other factors of manipulation, resulting in The same technique is used in various ways, with varying effects. The emergence of motion capture technology makes it possible to quantify the force, direction, time, speed and other factors in manual operations, and also lays the foundation for the standardization of manual operations. This article provides an overview of the research progress of motion capture technology in the field of massage manipulation biomechanics. The summary report is as follows.

Motion capture technology was proposed by psychologist Johansson in the Moving Light Display experiment in the late 1970s [2]. Subsequently, the technology continued to develop and improve, and was gradually used in many fields. There are many types of motion capture technology, which can be classified according to real-time performance, location, application angle, working principle, etc. Currently, the more commonly used classification methods are based on working principles, which can be divided into five types: mechanical motion capture, electromagnetic motion capture, acoustic motion capture, optical motion capture and video-based motion capture. Among them, the optical motion capture system uses a high-resolution infrared camera to capture the motion information of key points on the surface of the research object at high speed, and through real-time or post-processing, the digital motion trajectory of the research object can be accurately obtained. With its advantages of flexibility and efficiency, motion capture systems have currently been applied in research in biomechanics, ergonomics, simulation training and other fields [3-4].

Motion capture technology can track the motion trajectory of marked objects in three-dimensional space, and analyze their motion patterns by collecting, recording, and measuring the kinematic and biomechanical parameters of the objects. When the motion capture system obtains the parameters of the human skeletal system, the human body is usually understood to be composed of 15 to 20 joint points [5]. It is measured by placing marking points on the subject's body surface and capturing the marking points on the subject's body surface. The position and movement direction of the human body in space. After real-time or post-processing of this movement information, the movement parameters of the described object can be obtained. This provides favorable conditions for in-depth study of the biomechanical mechanism of manipulation and assessment of the safety of the manipulation [6].

2 APPLICATION OF MOTION CAPTURE TECHNOLOGY IN BIOMECHANICAL RESEARCH ON CERVICAL SPINE AND UPPER LIMB MANIPULATION

Guo Xin et al. [7] used a high-speed infrared motion capture system and a force plate to obtain the kinematics and motion mechanics parameters of the operator's manual therapy during the cervical spine extension and traction maneuver on subjects. Through research, they believed that The kinematics and motion mechanics parameters of the

cervical spine extension technique have certain regularities, which plays an important role in the clinical promotion and standardization of this technique. When Feng Minshan et al. [8] studied Professor Zhu Liguo's cervical spine rotation lifting technique, they used motion capture technology to conduct dynamic capture and recording, and obtained the important motion mechanics and kinematic parameters during the implementation of the technique, and used the obtained rotation lifting technique. The movement trajectory of the manual operation is displayed in the form of an animated video. The results show that: the pulling direction of the cervical spine rotation lifting method is mainly vertical and upward, provided that the neck muscles are fully relaxed, and the key points of the pulling action are "fast speed and small amplitude". Ryu et al. [9] used 3D motion capture technology and pressure sensors to study the pressure pattern and finger movement trajectory of the operator's hand when massaging the neck and shoulders (trapezius, levator scapulae and deltoid muscles). The results showed that: During the massage process Each muscle is subject to different pressures, and the movement trajectories of the surgeon's fingers are also different. The trapezius muscle bears greater pressure, longer massage time, and greater pressure time integration than other muscles. Deng Zhen et al. [10] studied the cervical spine rehabilitation procedures in Shi's Department of Traumatology. By analyzing and summarizing the motion data of the shoulder, elbow, knee and ankle joints collected by the three-dimensional motion capture system, they believed that during the manipulation process The patient's lower limb joints need to remain stable. If the ipsilateral knee joint flexion and extension can be used to coordinate the upper limb to exert force, better results can be achieved. When Zhu Liguo et al.[11] studied the cervical spine rotation technique, they used body mechanics technology to obtain a series of data such as the preload force, maximum force, and pulling force of the technique, and also used a motion capture system to obtain the operation of the technique. Motion trajectories and motion mechanics parameters. After analysis, it is believed that there is no significant difference in the force characteristics of the operation between the left and right hands, and the difference in the cervical spine rotation operation technique is related to the body mass index; there is a correlation between the size of the preload force and the size of the pulling force. With the preload As the force increases, the pulling force also needs to increase accordingly. Geng Nan et al. [12] conducted a preliminary quantitative and objective study on the operating characteristics of the cervical spine positioning and rotational pull method, and used a motion capture testing system to collect the kinematic parameters of the operator and subjects during the manual operation. The results showed that: In the pulling phase, the average forward flexion angle of the subjects was about 3.73°, the average lateral flexion angle was about 0.5°, the average rotation angle was about 10.2°, and the instantaneous pulling time was about 0.101 6 s. It is considered that This technique is a comprehensive process of forward flexion, lateral flexion and rotation of the cervical spine. Wang Pingping[13] studied the motion trajectory characteristics of the frozen shoulder joint under the intervention of the three -dimensional dynamic stretch and rotation method, and used a motion capture system to quantify the average angular velocity, maximum angular velocity, maximum angular acceleration of the glenohumeral joint and the amplitude of the frozen shoulder. Analysis, the results show that: compared with the across-body adduction-external rotation method and the abduction-internal rotation method, the average angular velocity, maximum angular velocity, and maximum angular acceleration of the frozen glenohumeral joint under the intervention of abduction-stretching method are smaller; when limiting humeral rotation When the ligament is tense, the rotation angle of the humerus on the affected side is within the range of angles that can be achieved by humeral rotation. Lu Jie et al.[14] studied the one-finger meditation technique through motion capture technology combined with the FZ-1 Traditional Chinese Medicine Massage Technique Dynamometer Analyzer. They collected the kinematic parameters during the operation of these two techniques, and based on the characteristics of these parameters, they successively A 4-member, 5-node one-finger meditation biomechanical model and a simple biomechanical model including the hand, ulna and radius were established. At the same time, the force of each force-bearing part during the manual operation was calculated.

3 APPLICATION OF MOTION CAPTURE TECHNOLOGY IN BIOMECHANICAL RESEARCH ON LUMBAR SPINE MANIPULATION

Triano et al. [15] used a motion capture system to study mechanical parameters such as preload force, pulling time and speed during manual operation, and proposed the mechanical parameters of the "high-speed and low-amplitude impact technique" for the lumbar spine. In order to explore the mechanical mechanism of rotational manipulation on intervertebral discs, Zhang Jun et al.[16] used the Motion motion capture system to collect the left-right rotation, flexion -extension, and lateral bending angular displacement of the vertebral body in 12 cases of lumbar intervertebral disc pathological conditions. The results showed that rotational manipulation is used to treat lumbar disc herniation. The mechanical mechanism of the disease is the conjugate motion of the spine, and rotation techniques have inconsistent effects on the forces acting on different vertebrae. When Wang Wei et al. [17] studied the kinematic rules and mechanisms of Wei's traumatology techniques of "suspended foot pressure knee" and "waist lift" in the treatment of lumbar disc herniation, a three-dimensional motion capture system was used to collect the subjects' movements during the operation of the techniques. Based on the scientific data, the relative movement angles of the hip, knee and ankle joints, as well as the flexion (extension), abduction (adduction) and axial rotation of each joint are calculated, and the average movement angle and trajectory pattern of the joints are calculated. When studying the seated lumbar rotation technique, Gao Chunyu [18] used motion capture technology to obtain more detailed kinematic parameters, and believed that the preload force, maximum force, rotation force and other kinematics of the left and right hands when performing the seated lumbar rotation technique There is no significant difference in the parameters, and there is a positive correlation between the preload force and the turning force during the operation of this technique.

4 CONCLUSION

In short, the application of motion capture technology in the biomechanical research of massage techniques has solved the problem of kinematic analysis of massage techniques and accelerated the progress of biomechanical research on massage techniques. It has also transformed the research on massage techniques from subjectivity and experience to standardization, visualization and objectification, laying an extremely important foundation for the clinical promotion and inheritance of massage techniques.

Although motion capture technology has been widely used in the study of human biomechanics, there are still many problems with this technology: ① The sample sizes of existing studies are small, and they fail to strictly follow the basic principles of clinical trials and fail to control Good at non-processing factors such as gender, age, race, height, body mass, etc.; ②The motion capture system and data analysis and collection system are relatively complex, the processing speed of high-dimensional data is slow, and there are perspective occlusions and skin marks in modeling, simulation and motion analysis. Movement errors and other factors that affect the research results [19]; ③ In complex and diverse scenes, the problem of automatic separation of people and backgrounds will occur, and multi-person motion capture technology is still not perfect [20]. However, I believe that with the development of modern technology, motion capture technology will definitely break through many limitations, continue to improve, and solve more problems in the biomechanical research of massage techniques.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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