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ORIGINAL RESEARCH

Application of Trimano Universal Manipulator in Clinical and Teaching of Shoulder Arthroscopy

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Abstract

Orthopaedics is a subject with a wide variety of diseases and strong specialties, among which the sports medicine subspecialty is a rapidly developing specialty. In particular, the sports medicine department has been subdivided in the orthopedics department of the national super first-class comprehensive hospital, and on the basis of the sports medicine specialty, professional groups have been subdivided by location, and teaching tasks from various sources and at different levels have been undertaken. In the field of shoulder arthroscopy, the application of the Trimano universal mechanical arm provides a simple and feasible scheme for the minimally invasive treatment of shoulder joint diseases. At the same time, standardized coordination can be provided for the treatment posture of shoulder arthroscopy with individual differences, providing a high standard model for the teaching of sports medicine specialty.

Keywords

Orthopedics, Sports medicine, Shoulder arthroscopy, Universal mechanical arm, Clinical teaching

Introduction

Currently, the sub specialty divisions of orthopedics are becoming increasingly detailed and specialized, which also poses challenges to clinical teaching work [1]. Arthroscopic minimally invasive technology is known as one of the most remarkable achievements in the field of orthopedics. Due to its minimal surgical trauma, clear vision, accurate operation, rapid recovery, and satisfactory curative effect, it has become the preferred diagnosis and treatment technology for major joint diseases of the shoulder, elbow, wrist, hip, knee, ankle, and other limbs. In China, the department of orthopedics in a comprehensive hospital and an affiliated hospital of a medical university usually undertakes teaching tasks from multiple sources and levels, such as undergraduate interns, standardized resident trainees, graduate students, and advanced students. The teaching teachers are mostly the backbone of clinical work, undertaking heavy clinical and scientific research tasks. This is especially true for the orthopedic subspecialty sports medicine specialty, which is becoming increasingly specialized. The sports medicine specialty has subdivided professional groups by location, and undertakes teaching tasks from multiple sources and at different levels. This configuration is not available in all hospitals. Therefore, how to achieve different levels of teaching objectives for different teaching objects in sports medicine is a huge challenge [2].

Shoulder surgery and arthroscopy are important components of sports medicine, requiring a specialized learning curve. In the face of this problem, we explore the application of the Trimano universal mechanical arm to achieve standardized clinical operation of shoulder arthroscopy, while saving professional learning curve time, reducing the teaching burden of teachers, and improving the teaching effectiveness of specialized physicians.

Clinical application of trimano universal robotic arm in shoulder arthroscopy

The development of sports medicine sub specialty

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is rapid. Currently, it can be divided into sub specialty groups such as shoulder, knee, hip, ankle, elbow, and wrist according to location. However, the main clinical teaching content is concentrated in the four professional groups of shoulder, knee, hip, and ankle. Among these professional groups, the surgical posture of shoulder arthroscopy is the most complex and demanding, and the preparation of its surgical posture has a direct impact on intraoperative diagnosis, operation, and postoperative rehabilitation. Due to the importance of posture preparation in shoulder arthroscopy surgery, it is particularly important in clinical teaching, as it is the most important part of the learning curve of shoulder arthroscopy and lays a solid foundation for clinical teaching applications.

At present, there are not many top tier hospitals in China with sports medicine departments. Among these specialties, shoulder arthroscopy is widely used for treatment. For traumatic and degenerative rotator cuff injuries, acromion impingement syndrome, shoulder joint instability, and frozen shoulder diseases, arthroscopic treatment of the shoulder has obvious advantages. The conventional shoulder arthroscopy positions include lateral decubitus position and beach chair position, and the standardization of posture is of great significance for the clinical diagnosis, treatment, and learning curve of shoulder arthroscopy. The commonly used lateral decubitus positions are often maintained by external fixations, with the advantages of simplicity and low cost. The disadvantages are small flexibility and individual differences. For patients with special postures and physiques, the maintenance force is small, and the operation is difficult, especially for patients with large body weight and high BMI index. This affects subsequent arthroscopic operations, makes it difficult to maintain joint gaps, loses good intraoperative vision, and makes it difficult to maintain surgical results.

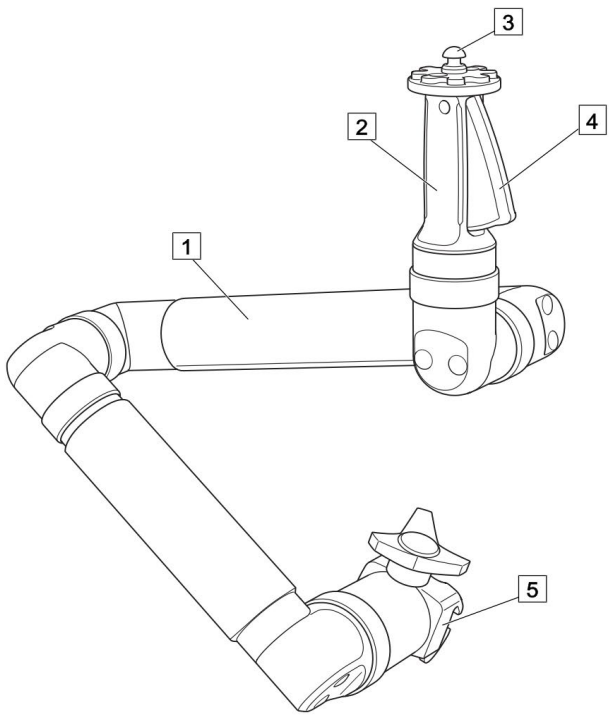

Figure 1: TRIMANO support arm: (1) TRIMANO 3D support arm; (2) Release handle; (3) Pin mounting point; (4) Release button; (5) Clamp.

The Trimano system of the universal robotic arm (GXB No. 20170531) approved for domestic use by German MAQUET Co., Ltd. in 2017 solved the above problems. The Trimano universal robotic arm is designed purely mechanically, without the need for any pressurized gas or power supply; Not limited by the model of the operating table, it can be connected to various edge rails of the operating table, with one click start stop, suitable for shoulder joint side position and beach chair position. In the standard lateral position, the entire system is controlled by one hand and can simultaneously lock and release the six joints of the robotic arm, with each joint having a 360 degree full angle range of motion; With a specialized shoulder joint adapter, independent components can move freely without restrictions, and after each component is connected in sequence, it can lock itself. The structure of the Trimano universal robotic arm and shoulder adapter is shown in Figure 1 and Figure 2. Our department started using the Trimano universal robotic arm in April 2021, and by June 2022, we have successfully completed more than 410 shoulder arthroscopic surgeries, maintaining stable postures, facilitating operation, teaching, and satisfying clinical outcomes.

Teaching points of the trimano universal robotic arm in the learning curve of shoulder arthroscopy

The specialized field of sports medicine is highly specialized, targeting a teaching population that is different from the general teaching population of major surgery in tertiary hospitals. The main focus is on senior graduate and advanced students with experience in trauma and arthroscopic clinical operations, whose clinical experience and teaching objectives are basically the same. Most advanced physicians have been engaged in clinical work in their original units for many years, possessing a certain theoretical foundation and clinical operational abilities. They are able to master the diagnosis and treatment of common and frequently occurring orthopedic diseases and have certain teaching experience [3-6]. Most graduate students have completed theoretical teaching for undergraduate interns and trainees, and have a firsthand understanding of the learning objectives and needs of undergraduate interns and trainees. They possess certain clinical experience and skills.

Based on these situations, in clinical teaching, we standardize the application steps of Trimano and develop appropriate standard solutions to meet the different needs of different teaching objects: 1. Based

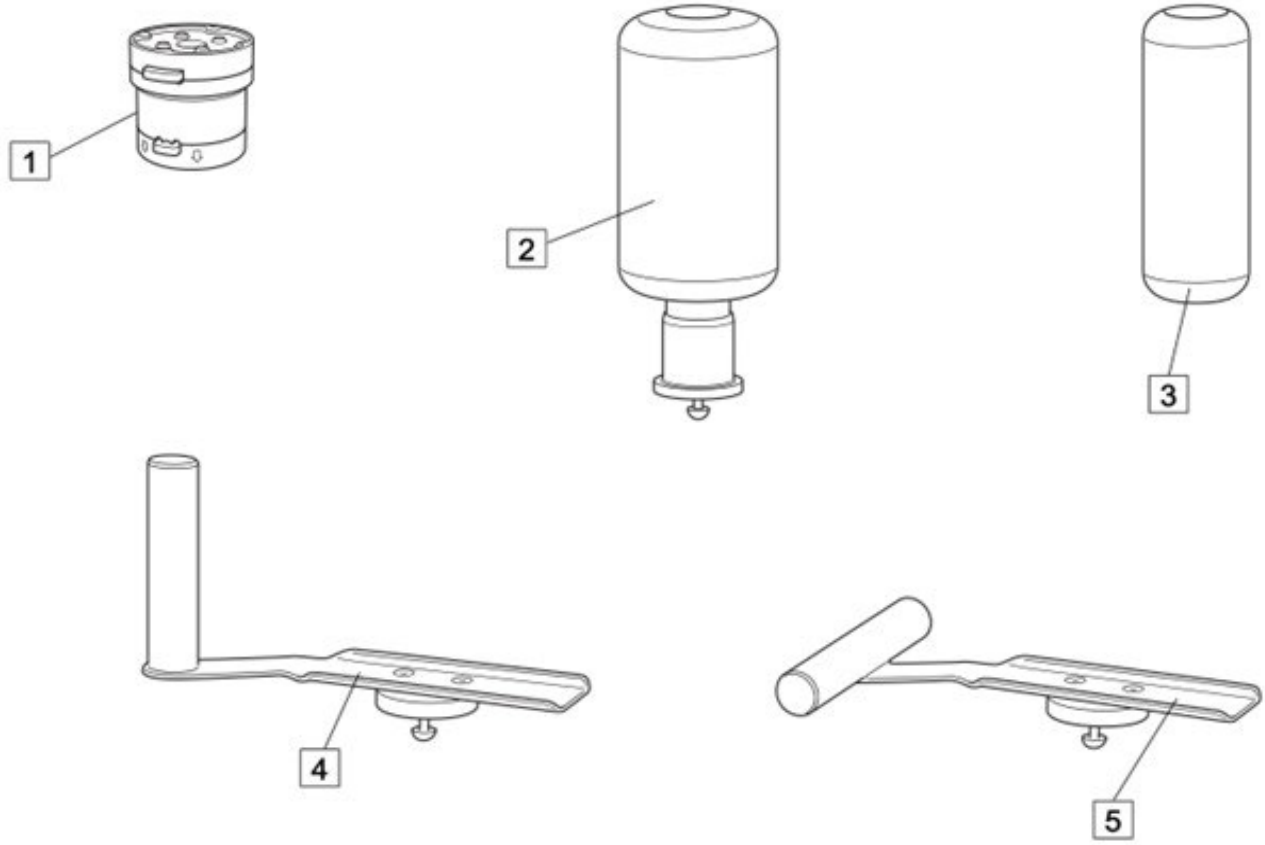

Figure 2: Accessory for arm/hand application: (1) TRIMANO adapter; (2) Countertraction post with large pad; (3) Small pad for countertraction post; (4) Arm rest for BEACH CHAIR; (5) Arm rest for lateral position.

on the specific situation of the patient's shoulder joint surgery, fix the Trimano universal robotic arm on the track of the operating table. 2. Take out the shoulder joint adapter and align it with the top of the universal arm. Gently press, hear a "click" sound, and clearly feel that the adapter is connected successfully. 3. The yellow start stop button of the Trimano universal robotic arm allows you to freely adjust the angle and direction 360 degrees by holding and pressing it all the way with one hand. Once you release your hand, fix it. Be sure to press hard to the bottom to start adjusting, and fully release before fixing the position. 4. Pay attention to the emphasis on aseptic operation in teaching. Take a disposable sterile arthroscope cover, insert it into the adapter from the top, and go all the way to the connection between the universal robotic arm and the operating table. 5. Carefully connect the shoulder joint surgical accessories to the adapter, taking care not to use force to avoid damaging the device and damaging the sterile environment.

Through the above steps, the surgical purpose of using the Trimano universal robotic arm to assist in shoulder arthroscopy operation and maintain a standard lateral position position can be achieved, as well as the teaching objectives of the standard operating position requirements for shoulder arthroscopy. At the same time, based on our application experience, we have summarized the key points and precautions for the use of a universal robotic arm in shoulder arthroscopy operations in teaching and clinical practice: 1. The main arm of the Trimano universal robotic arm must be firmly installed on the surgical bedside guide rail, and the adapter must be firmly installed on the main arm; The forearm accessories for the shoulder surgical position must be firmly seated on the adapter. 2. The yellow start stop button of the main arm must be pressed to the bottom during operation, otherwise it may cause damage to the equipment interior. 3. Avoid collisions and falls during the use of the Trimano universal robotic arm, and unauthorized disassembly is prohibited. Adapters and shoulder accessories can be disinfected under high temperature and pressure.

Conclusions

In the clinical teaching process of sports medicine specialty, how to implement teaching plans determines the quality of teaching is an important strategy to achieve teaching objectives. At present, there are various teaching methods, and "mentoring" is a simple and effective way to cultivate medical talents. Sports medicine specialist training physicians have certain clinical experience and practical operational abilities, and teaching teachers should impart their accumulated work experience and thinking processes to students on the specialized learning curve. The preparation of posture for shoulder arthroscopic surgery in sports

medicine is of great importance, so it is particularly important in clinical teaching. It is the most important part for sports medicine specialists to learn the curve of shoulder arthroscopy. The use of the Trimano universal robotic arm in conjunction with contact shoulder arthroscopy has played a very helpful role in surgical operations and clinical teaching applications. It is simple, clear, convenient, and reliable, and can standardize and unify the preoperative and intraoperative positions of shoulder arthroscopy. In the later stage, it can be organically integrated with remote medicine and other fields [7-11], establishing a more comprehensive and standardized shoulder arthroscopy specialized teaching platform, which can facilitate specialized surgical operations and teaching.

Author Contributions

Wei Li and Dongqiang Gu designed and directed the study, Dongqiang Gu, Lei Chen and Haoran Guprepared and drafted the manuscript. All the authors have read and approved the final manuscript. Dongqiang Gu and Haoran Gucontributed equally to this work.

Conflict of Interest

The authors declare no conflict of interest.

Availability of Data and Materials

The authors declare all data and material availability.

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