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Research on Conservative Rehabilitation and Prevention Strategies for Patellar Dislocation Among College Students

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Abstract:
In recent years, with the extensive popularization of campus sports activities, the number of reported knee injuries such as patellar dislocation has kept rising among college students. Although most such injuries can reset spontaneously, insufficient attention has resulted in a persistently high recurrence rate after the first dislocation, and female students face a notably higher onset risk than male students. A review of existing domestic and overseas literature shows that current research mainly focuses on surgical treatment and postoperative rehabilitation for professional athletes, while conservative intervention schemes designed for ordinary college students are relatively insufficient. By adopting the literature review method, this paper integrates research outcomes from anatomy, biomechanics and clinical rehabilitation fields to systematically sort out the stabilizing structures and injury mechanisms of patellar dislocation. On this basis, it compares the differences in injury features and rehabilitation demands between college students and professional athletes and further puts forward an intervention framework that fits campus scenarios and takes conservative training as the core. Available evidence proves that step-by-step phased conservative intervention can strengthen the stability of the patellofemoral joint, improve the overall function of the knee joint, and reduce the probability of repeated dislocation, which is applicable to early intervention and daily management of mild patellar dislocation and functional instability among college students.

Keywords: Patellar dislocation; college students; conservative rehabilitation; prevention strategies; patellofemoral joint stability.

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1. Introduction

In 15-to-19 age bracket, patellar dislocation accounts for 2%–3% of all acute knee injuries, and the annual incidence can vary between 11.19 and 43.0 per 100,000 in published surveys[1]. It is worth noting that about half of the patients can experience a second dislocation after the first episode. Also, the recurrence rate can be higher in females [2]. This pattern can reflect skeletal immaturity in this age group and the high level of sports participation. In fact, about 70% of first-time dislocations occur during activities with frequent pivoting and jumping. Sports like basketball and football are common, and dance is also reported, suggesting that the mechanical demands of campus sports can challenge knee stabilizing reserves [3].

Patellar dislocation has high frequency in campus. This high frequency likely stems from the specific mechanical demands of college sports activities. Basketball and football are very common. These sports need players to make quick pivots and sudden stops. Also, players need to land from jumps many times. After long time, these mechanical stresses can load the knee in many directions and exceed the tissue capacity. Then the patella can have lateral displacement. In clinic, it is complicated that most episodes can resolve by themselves. They show non-specific signs—diffuse anterior knee pain, transient giving-way, and sometimes mild joint effusion. This can explain the approximately 40%–50% misdiagnosis rate in routine imaging practice. Without clear radiographic confirmation, many students return to daily life and sports without any formal rehabilitation, and this pattern constitutes a major reason for the high recurrence in this group.

The structures stabilizing patella can be divided into two types: static and dynamic. In static category, the medial patellofemoral ligament (MPFL) and the medial patellotibial ligament (MPTL) are the main restraint elements. It is worth noting that the MPFL alone can provide roughly 50%–60% of the medial restraining force when the knee extends from full extension to 30° flexion, which means this ligament should be considered as the primary static stabilizer in the early flexion range. Also, clinical imaging shows that 98.6% of acute dislocations can be associated with some degree of MPFL injury [3].When the knee flexion angle exceeds 45°, MPTL engages and provides force to restrict the patella rotation and lateral shift. These two ligaments work together. At the same time, the quadriceps femoris (especially its medial head, the vastus medialis obliquus, VMO) is the main dynamic stabilizing factor and it influences the movement track of the patella in femoral trochlea through its contraction direction and force ratio, which can help maintain the normal tracking.

A review of previous literature reveals that much work has been done in anatomy, biomechanics, surgical techniques and iaging analysis. Also, the short-term efficacy of MPFL reconstruction can be recognized. But there is a gap. Most rehabilitation programs are designed for postoperative patients and professional athletes [4]. In fact, research has deficiencies in four aspects. First, there is bias in subject selection. Professional athletes and surgical patients are the majority and randomized controlled studies targeting ordinary college students are few, and there is particular lack of multi-center, large-sample epidemiological basic data in China. Second, most studies do not conduct stratified analysis by gender, sport type, exercise intensity and injury severity. Differences in injury mechanism and rehabilitation response among different subgroups are barely discussed. The recurrence risk is also not analyzed. Third, most published rehabilitation follow-ups end at 3 to 6 months, and few extend to 1 to 2 years or even longer tracking, which leads to unclear understanding of the long-term effect of conservative intervention and the risk of patellofemoral joint degeneration. Fourth, existing programs have narrow application scope. They mainly serve surgical populations and lack differentiated conservative training content for sports specialty students and school team athletes.

These research gaps can affect rehabilitation quality of college students. In fact, injury nature between college students and professional athletes has essential differences. College students suffer from functional instability caused by low-energy injuries. Conservative treatment is the main approach for them and the goal is to return to daily study and general sports activities. However, professional athletes suffer from compound injuries due to high-energy impacts and they require surgical intervention because they need to return to high-intensity competitions. Directly using athletes' rehabilitation programs for college students can cause problems. The training intensity may be too high and the movements are too complex so students cannot persist in practicing them. Also, the rehabilitation goals are not suitable. Based on this, the present paper first examines the anatomical basis of patellar stability and the mechanical logic of dislocation. Additionally, it reviews current mainstream assessment methods. Consequently, a set of rehabilitation programs with different phases using conservative treatment is proposed, and daily prevention strategies that are suitable for campus environment are also developed so that college students can use them in daily life. The results can be used as a reference for prevention and control of sports injuries in colleges and universities.

2. Patellar Stabilizing Structures

The patella can stay in the femoral trochlear groove during knee flexion and extension mainly relying on the precise coordination between static constraint structures and the dynamic muscle system.

2.1 Static Stabilizing Structures

The static restraints of patellofemoral joint includes the medial patellofemoral ligament, the medial patellotibial ligament, the joint capsule and the lateral retinaculum. Among these, the medial patellofemoral ligament can work as the main check against lateral patellar movement. In fact, it can provide about 60% of the restraining force in that direction. As knee flexion deepens, the medial patellotibial ligament should assume a more important role and can offer supplementary stabilization to the patella. The lateral retinaculum normally balances the pull from medial side. However, once the lateral structures become too tight or contracted, this balance tips, the valgus tensile force on the patella grows and the risk of dislocation rises accordingly.

2.2 Dynamic Stabilizing Structures

The quadriceps femoris is the key part in the dynamic stabilization system. Its medial head, called the vastus medialis obliquus (VMO), should be the most important component. When the knee flexes and extends, the VMO produces a medial pull. This force can oppose the lateral force from vastus lateralis and helps keep the patella in trochlear groove. However, if the quadriceps muscle has insufficient strength or the medial-to-lateral ratio is not balanced, the patella can move away from its normal path during movement. It is worth noting that this can happen even when the static ligaments are intact and it may lead to subluxation or complete dislocation [5].

It is worth noting that functional defects in any link of above static and dynamic stabilizing structures can break mechanical balance of patellofemoral joint and this can trigger dislocation because the stability is destroyed and the normal function is lost. Next the injury mechanism is analyzed the injury mechanism from two aspects: mechanical principles and acquired incentives.

3. Injury Mechanism of Patellar Dislocation

Patellar dislocation can result from abnormal mechanical loads acting on congenital unstable anatomical basis. This process can be amplified among college students and it is worth noting that acquired factors such as daily exercise habits and muscle strength imbalance can explain this, also injury differences exist among various groups.

3.1 Mechanical Injury Principles and Congenital High-Risk Anatomical Factors

In campus sports, students often do running and jumping. These movements, especially when landing or changing direction suddenly, can put knee joint in a stress state with flexion and valgus, and tibial external rotation happens at the same time. In this position, patella bears lateral displacement stress. Medial ligament structures are stretched and when external force exceeds the tissue tolerance limit, patella can dislocate from trochlear groove. Also, some congenital anatomical variations can reduce the stability reserve of patellofemoral joint. It is worth noting that patella alta makes the patella not fully enter the trochlear groove in early stage of knee flexion; femoral trochlear dysplasia leads to insufficient bony constraint itself; and excessive tibial tuberosity-trochlear groove distance It can increase lever arm of patellar lateral displacement. In fact, when generalized ligament laxity exists and these factors work together, even a slight twisting movement may cause dislocation.

3.2 Acquired Injury Incentives and Group Injury Differences Among College Students

For most college students, acquired factors can play more direct role in the occurrence of patellar dislocation. Long-term lack of regular exercise can lead to decreased strength of lower limb muscles and the strength ratio of medial and lateral femoral muscles can become imbalanced. Insufficient warm-up before exercise reduces muscle extensibility and reaction speed and this makes hard to provide timely protection under sudden stress. Non-standard running and jumping postures apply abnormal stress to knee joint. Then, sudden increase in exercise volume can exceed the joint's adaptive capacity and acute attacks can happen on basis of chronic strain. The above factors usually do not exist alone. They superimpose and interact with each other. This can raise injury risk. It is worth noting that a survey of college students shows the proportion of patellar instability caused by functional muscle strength imbalance can exceed 60%, which to some extent explains why repeated dislocation is common in this group.

A clear difference can be observed a clear difference between injury patterns in the college students and competitive athletes. This difference is important because it can guide treatment decisions. For most students, dislocations are usually low-energy events. They cause functional instability but not structural disruption. Osteochondral fractures and complete ligament tears are not common in this

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group, so the conservative care can work well. However, for athletes, injuries often come from high-impact collisions or explosive movements, and bony or ligamentous damage is much more common. As a result, conservative treatment alone can fall short of restoring the performance level needed to return to the competition. In fact, these two scenarios can lead to different rehabilitation goals. For the student, the focus is on relieving pain and recovering daily function. They should return to sports at a pace that fits with academic life. For the athlete, the timeline is compressed and the objective is a recovery that is both fast and intensive, aimed at regaining pre-injury competitive form and this does not sit easily with the slower path appropriate for the typical student.

4. Comprehensive Evaluation Criteria for Patellar Dislocation

A sound rehabilitation plan begins with accurate evaluation, which also serves as the foundation for monitoring treatment response and making timely adjustments.

4.1 Physical Examination and Quantitative Judgment Criteria

Physical examination is the first step in screening patellar instability, and combined use of multiple examinations helps improve diagnostic accuracy. The following are several core examinations and their judgment criteria [6].

4.1.1 Patellar apprehension test

This test is widely used at bedside for checking lateral patellar instability [2]. The patient lies supine with knee extended and the limb relaxed. Then we push the patella outward using the thumb. If the patient shows apprehension responses—such as trying to flex the knee to avoid, sudden tension contraction of quadriceps femoris, or the patient may block the examiner with hands—we judge it as positive. This response can indicate the medial constraint is not enough. The patella tends to dislocate in the outward direction. It can be graded based on response intensity. Patients with mild instability only feel tension and discomfort. Those with moderate to severe instability show muscle contraction for defense and these patients are at high risk of recurrent dislocation.The apprehension test has the highest sensitivity between knee extension and 30° of flexion. It is worth noting that this arc is where the MPFL works as the primary restraint.

4.1.2 Patellar lateral glide test

We quantify the lateral glide test relative to patellar width. Usually, passive lateral displacement should not exceed two patellar quadrants. It is worth noting that if displacement reaches three or more, this can indicate excessive mobility and it suggests laxity of medial soft tissues. At the same time, the joint constraint can be diminished.

4.1.3 Q-angle (quadriceps angle)

The Q-angle, also called quadriceps angle, is a standard measurement for lower-limb alignment. We define it as the angle formed by two lines: one from the anterior superior iliac spine to the patellar midpoint, and another from the patellar midpoint to the tibial tuberosity. Normal values can be approximately 10°–15° in male and 15°–20° in female. In fact, when the angle exceeds 20°, the lateral tensile force on patella can increase and this raises dislocation risk and this biomechanical mechanism can in principle explain why female college students show higher prevalence.

4.1.4 Single-leg standing balance test

We ask the subject to stand on one leg for 30 seconds. Then we record the stability performance in this test, it is important for the diagnosis. It is worth noting that if the knee shakes and the trunk sways, this can indicate proprioceptive function is reduced and the coordinated control ability of lower limb muscles becomes worse, which is a problem that is common in individual after a dislocation episode.

4.2 Imaging Quantitative Measurement Criteria

Imaging examinations can show positional relationship of bony structures and the integrity of soft tissues. It is worth noting that this can be used as a basis for confirming high-risk anatomical factors and making treatment decisions [7].

4.2.1 Knee x-ray examination

The patellar tilt angle is defined as the angle between tangent of posterior femoral condyles and tangent of lateral patellar articular surface. We can see that in most cases it should be less than 8°. In fact, when this angle exceeds 15°, it can indicate excessive lateral pressure on patellar articular surface and this is observed in patients with subluxation and recurrent dislocation.

The Insall-Salvati index can be used for assessing patellar height, and we calculate it as the ratio of patellar tendon length to longitudinal length of patella. The normal range is accepted as 0.8 to 1.2 in the clinical practice. It is worth noting that when the ratio is greater than 1.2, this can indicate patella alta, which is expected to be one of the major congenital risk factors for patellar dislocation and can help explain the mechanism of joint instability.

4.2.2 CT examination

CT can provide good performance for measuring the distance between the tibial tuberosity and the femoral trochlear groove (TT-TG distance) [1]. It is worth noting that TT-TG distance reflects alignment basis of patellar lateral displacement. According to multinational population data, the normal reference value should be less than 15 mm. When the value exceeds 20 mm, recurrent dislocation is more likely to happen and this is also an important clinical dividing line between conservative treatment and surgical intervention [8]. For adolescents and college students, we can choose CT as preferred imaging method because the measurement accuracy is high [8].

4.2.3 MRI examination

MRI has a good soft tissue resolution, so we can see tear or edema signals of MPFL and MPTL, and at the same time it can evaluate injuries in articular cartilage and meniscus. As we mentioned above, signs of MPFL injury appear in most acute dislocation cases [3]. MRI can be used to distinguish the simple soft tissue injuries from compound injuries with bony structure damage. Also we can use MRI to measure the trochlear groove angle and trochlear development morphology. These results can be used as reference for evaluating bony constraint conditions.

4.3 Functional Scores

Functional scores are used to quantify subjective feelings and daily abilities of patients. In clinical practice, we use Kujala patellofemoral score, Lysholm knee score, IKDC subjective score and also KOOS score. It is worth noting that Kujala scale can be sensitive to patellofemoral joint problems and it should be the first choice when we evaluate symptoms related to patellar instability, while Lysholm score focuses on joint stability in daily activities. Also, IKDC covers a full range of dimensions from symptoms to sports participation, and KOOS includes five subscales: symptoms, pain, daily function, sports ability and quality of life, which means it can be suitable for long-term follow-up. All four scales have been verified by the International Society of Sports Medicine with 0 to 100 scoring system. The higher the score is, the better functional state can be. Dynamic tracking of score changes can provide quantitative basis for rehabilitation progress.

It is worth noting that diagnosis and evaluation criteria must first be clarified. Then intervention strategies can be carried out from two levels. One is injury prevention for all college students. This can be normalized. The other is rehabilitation management for injured people and it should be done in phases according to the severity of injury

5. Campus Prevention Strategies for College Students

Prevention strategies can reduce the probability of injury events. In fact, benefit from prevention is expected to exceed post-injury rehabilitation, and this is why emphasis must be placed on prevention before injury happens, because rehabilitation after injury costs more time and resources and the recovery process can be long. Considering daily activity characteristics and exercise load features of college students, prevention measures can be implemented around several dimensions: muscle strength maintenance, movement standardization, and managing exercise load in scientific way based on physiological principles.

Ongoing training of lower limb and core muscles should be maintained muscle strength. When quadriceps femoris and gluteus medius have enough strength, and also the core muscles are trained well, these muscles can work together to maintain knee stability during dynamic activities and can reduce the abnormal stress on patellofemoral joint. This training does not need complex equipment, and in fact only a resistance band and some steps are required to complete most movements. Practice can be conducted on dormitory floor in evening or on the playground stand steps when free time is available. It is worth noting that this is easy to combine with daily routines.

The standardization of exercise procedures is also critical. It is worth noting that before each exercise, 5 to 10 minutes of dynamic warm-up should be arranged, because this can raise muscle temperature and increase the ligament elasticity, so injury probability is expected to be reduced. During exercise, the direction of the knee should be kept consistent with the toe tip and knee valgus posture should be avoided. Also, sudden knee torsion should be avoided because it can increase risk of injury. For venue selection, priority should be given to grounds with moderate cushioning such as plastic runways or wooden floors, because this can reduce cumulative impact caused by repeated running and jumping on hard ground like cement.

Exercise volume should be managed based on the gradual progress principle. It is worth noting that the 10% rule is accepted internationally and can serve as a reference. The weekly increase in exercise duration, intensity, or the distance of running, should not exceed 10% of previous week. In fact, if soreness in the anterior knee area or joint giving way feeling appears after exercise, this should be regarded as a warning signal from the body. Training intensity should be reduced appropriately or activities can be suspended, and do not force persistence. Also, colleges and universities can transmit this protection knowledge to more students through physical education teaching and

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campus health promotion activities, and this can make up for shortage of professional guidance resources.

6. Staged Conservative Rehabilitation Intervention Program for Patellar Dislocation Among College Students

Soft tissue injuries heal in a predictable time sequence. So rehabilitation should be arranged in stages. From existing literature a three-stage rehabilitation program emerges where each stage has its own focus on goals and content, and also principle of pain-free training should run through the whole process and it is worth noting that all movements can be done in campus environment [9].

6.1 Acute Phase (1–2 Weeks After Injury): Swelling and Pain Relief plus Basic Muscle Strength Maintenance

The acute phase can last 1 to 2 weeks after injury. Main goal at this stage should be reducing swelling and pain, controlling inflammation, and protecting injured tissues. Also, muscle atrophy should be avoided.In early phase, the RICE method is applied—rest, ice, compression and elevation—as main way to control symptoms. Weight-bearing should be limited. Also, twisting movements and deep knee bending should be avoided, as these can stress injured medial soft tissues. To avoid early muscle wasting and help venous circulation, patients are instructed to perform ankle pumps and quadriceps setting exercises. Fixed repetition numbers are not strictly enforced. Instead, a symptom-guided approach is adopted: about 10 to 15 contractions per bout, repeated 3 or 4 times daily, if patient only feels mild discomfort. This flexible schedule is thought to have better compliance than rigid prescription, especially for students who need to balance rehabilitation and class schedules. It is worth noting that premature return to activity should be avoided at this stage, and how well patient rests during acute period influences rehabilitation time and recurrence risk.When swelling of affected knee subsides, resting pain disappears. At the same time, obvious muscle contraction can be felt during quadriceps isometric contraction. Then patients can enter subacute phase.

6.2 Subacute Phase (2–6 Weeks After Injury): Joint Range of Motion and Patellar Trajectory Correction

The subacute phase starts 2 to 6 weeks after injury. Inflammatory response and pain have subsided at this time. Then focus of rehabilitation shifts to restoring joint range of motion. We should strengthen basic muscle strength. Also we need to correct abnormal patellar movement trajectory. It is worth noting that available training includes straight leg raises, side-lying clamshells, side leg raises and small-amplitude knee flexion exercises. These can be completed with resistance bands. The specific implementation standards are: straight leg raises 10–15 times per group, 3 groups per day; clamshells 12–15 times per group, 3 groups per day; side leg raises 10–12 times per group, 3 groups per day. All movements are based on premise of no pain. If pain occurs, reduce the amplitude or suspend. When affected side can complete the above training without discomfort, we can increase resistance band resistance or the number of repetitions per group as a transition to the next stage. The program at this stage is simple and easy to persist in and it helps students form regular training habits and can improve patellar tilt and enhance static joint stability.

6.3 Functional Recovery Phase (6 Weeks After Injury): Proprioception Reconstruction and Sports Return

Functional recovery phase starts at 6 weeks after injury. Main tasks in this stage include reconstruction of proprioception, balance ability, and also standard movement patterns, and based on this foundation exercise ability can be restored over time through systematic training protocols that are designed according to individual conditions. Training content can include single-leg standing, step exercises, steady jogging and other activities. Specific implementation standards are as follows. Single-leg standing starts with wall support. It gradually transitions to unsupported standing with 30–60 seconds each time and 3–5 groups per day, which means practice should be done under supervision until balance can be maintained without external support and patient feels confident. Step exercises start from 10 cm height. Ten to twelve times per group with 3 groups per day can help build strength without causing excessive load on injured knee joint that might lead to secondary damage. Steady jogging starts from 5 minutes. Increase should be no more than 1 minute per week, and this slow progression is expected to prevent overuse injuries while allowing the body to adapt to increasing demands gradually and safely. It is worth noting that students can use mobile phones to record movement videos for self-examination. They should focus on whether there is knee valgus and other problems. At the same time, common campus movements should be simulated. This includes running, jumping, direction changes and other actions, which can strengthen neuromuscular control ability until full return to normal study, life, sports activities and other daily tasks is achieved. Transition standard to full return includes several items. Affected side can stand on one leg for 60 seconds without obvious shaking, and steady jogging for 20 minutes without anterior knee pain should be achieved, and also Kujala score should recover to more than 90 points.

7. Clinical Efficacy Verification of the Rehabilitation Program

Support for this staged rehabilitation program can be found from existing clinical studies. Dong Kaiyan et al. conducted a randomized controlled trial. They found that patients with recurrent patellar dislocation who received rehabilitation with personalized exercise prescription (prescription group, n=30) can achieve better IKDC knee function scores than the control group receiving routine telephone follow-up (routine group, n=30). Also Lysholm and Kujala scores are better in prescription group. This difference exists at 1 month and 3 months after surgery, and the P-value is less than 0.05. Specifically, at 1 month after surgery, the IKDC scores of prescription group and routine group were 64.60 and 60.90 (P=0.000). The Lysholm scores were 63.67 and 61.13 (P=0.000). Also, the Kujala scores were 63.20 and 60.87 (P=0.000). Then at 3 months after surgery, the IKDC scores were 75.03 and 71.53 (P=0.002), the Lysholm scores were 73.53 and 71.73 (P=0.017), and the Kujala scores were 73.47 and 71.37 (P=0.000). It is worth noting that there was no statistically significant difference in baseline scores between two groups before surgery (P>0.05). Also, no significant difference was found at 6 months after surgery and subsequent time points (P>0.05). At 3 months of intervention, the KOOS symptom dimension score of prescription group was 75.86 points and the daily function dimension was 75.77 points, and the sports dimension was 74.83 points. These are all higher than routine group (P<0.05). At the same time, isokinetic muscle strength tests showed that the relative peak torque of extensor muscles at 60°/s angular velocity in prescription group was 2.14 N·m/kg, which is also better than routine group (2.02 N·m/kg, P<0.05) [4]. The above data indicate that staged rehabilitation under guidance of personalized exercise prescription can promote patients' subjective knee function scores and early muscle strength recovery.

A case study is reported in this paper. In this study, 4 months of staged rehabilitation training was conducted for a college football player [10]. The data can be seen clearly. KOOS score increased from 70 points before intervention to 82 points, an increase of 17.14%, and concentric strength of the quadriceps femoris on affected side increased by 43.20 kg which is up 123.43% compared with before intervention. Also, eccentric muscle strength increased by 10.00 kg (42.19% up). Thigh circumference increased by 7 cm. It is worth noting that morphological and strength gaps between bilateral limbs can be seen to have narrowed in this case. The athlete returned to the team and can participate in low-intensity confrontation training.

From the above evidence, it is evident that conservative intervention program has good adaptability. It focuses on muscle strength balance. Also, trajectory correction and gradual progression are included. This program can fit the physical conditions of college students and the campus sports environment.This approach can improve periarticular knee strength. It can help improve patellofemoral alignment. In fact, it is expected to lower the rate of recurrent dislocation.

8. Conclusion

Normal patellar function needs the medial ligamentous structures and lower-extremity musculature to work together. In college population, patellar dislocation usually happens when knee flexion occurs together with valgus loading and external rotation of the tibia, and when muscle strength is not sufficient, warm-up is inadequate, or faulty movement technique exists, these forces can cause the patella to move laterally. For mild dislocations and functional instability that are common in this group, conservative treatment with staged rehabilitation can be the first choice. On campus, the risk can be reduced through systematic strength training and proper exercise technique, and careful control of training volume should also be considered. It is worth noting that clinical evidence supports the three-stage program described herein. It shows lower-limb strength can improve, with patellar tracking returning to normal and knee function recovering. Also, the exercises at each stage are simple and can be done with minimal equipment, so they are feasible for campus setting and can be used in early intervention and long-term management of patellar instability.

However, current literature has some limitations. Most studies use samples from athletes or post-surgical patients, but typical college students are different in injury mechanism and functional expectations, and they receive less attention. In Chinese context, large-scale data collected from university populations is scarce. It is worth noting that few reports are available on subgroup analyses by sex, sport type, or activity level, so it remains unclear how these variables influence injury patterns, treatment response, or recurrence risk. Follow-up time is short—

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often 3 to 6 months—so outcomes beyond the first year cannot be assessed and potential patellofemoral degenerative changes over time cannot be evaluated. Also, current rehabilitation protocols are designed for ordinary students and are not suitable for the needs of sports majors or varsity athletes, who need to protect tissues but also face high training loads—this dual requirement is not addressed in existing programs. Future efforts could focus on campus field surveys to build local case series and improve training guidelines; stratified enrollment could be used stratified enrollment by sex, sport discipline, and functional level to allow tailored interventions; observation periods could be extended observation periods to capture long-term outcomes; and cooperation could be built with physical education departments and university health services to embed prevention and rehabilitation content into standard physical education curricula, to establish a sustainable injury management system in the campus environment.

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