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Implementing Medical Checkups to Prevent Sports-Related Injuries and Disorders

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Abstract: Sports related injuries and disorders have increased due to the spread of sports. To prevent such injuries and disorders and to improve activity levels further, medical checkups of individual athletes are conducted before, during, and after their performance, and the results are provided as feedback for athletes, coaches, and physicians. The checkup consists of three examinations: (1) an internal medical evaluation in which ischemic heart diseases and valvular diseases with fatal symptoms that are induced by sports are mainly checked, in addition to basic systemic diseases such as kidney, liver, and metabolic diseases, (2) brain surgery and orthopaedic evaluations in which basic brain disorders and susceptibility to head and limb injuries are checked, and (3) a physical strength evaluation in which basic physical performance and muscular strength of extremities and trunk, body fat rate, height, and body weight are checked during sports activities. It is very important that the data obtained from this examination is promptly converted as feedback for use by athletes, coaches and trainers, and to enable the physician to provide appropriate medical advice.

Key words: Medical checkup; Sports injury; Training

Introduction

Recently, due to the widespread popularity of sports among the general public, the number of people who enjoy participating in a variety of sports activities as a source of recreation has rapidly increased. The age of such persons has been noticeably increasing as well. When people who have few opportunities to engage in sports suddenly participate in these activities without adequate training, many different kinds of injuries and disorders can occur.

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Table 1 Items Examined during Sports-related Medical Evaluations

1. Internal medical evaluation
   (1) Past history and family history
   (2) Diet and types of food often consumed
   (3) Examination of peripheral blood sample (including anemia)
   (4) Respiratory function (plain chest X-rays and functional tests if required)
   (5) Renal function
   (6) Hepatic function
   (7) Circulatory function (resting and stress ECGs, echocardiograms, and treadmill if required)
   (8) CPK levels
2. Neurosurgical and orthopaedic evaluations
   (1) Past history
   (2) Head CTs or head, neck and lumbar MRIs
   (3) plain X-rays of the cervical vertebrae
   (4) plain X-rays of the lumbar vertebrae
   (5) Body type and muscle balance
   (6) Flexibility of joints
3. Physical strength evaluation
   (1) Morphology (height, body weight, cervical and abdominal circumference)
   (2) Percentage of body fat, lean body mass and lean body mass per height
   (3) Cervical flexor and extensor strength and its ratio
   (4) Knee flexor and extensor strength, extensor strength according to body weight and the ratio of flexor to extensor strength
   (5) Anaerobic power and anaerobic power according to body weight
   (6) Aerobic power and maximal oxygen intake

Fig. 1 Facility for training and exercise therapy

Meanwhile, those who take part in athletic sports have the need to acquire a higher level of skill and ability because the overall level in each sport has significantly increased over the years. This has also been true regarding the athletic levels demanded of growing school children, which is now at a higher plateau. Coinciding with such trends, athletes are more prone to experience sports injuries and disorders, and the types of injuries and disorders they sustain are now changing.

Medical checkups are used to evaluate individual sports performances prior to an athlete's actual engagement in such activities, and to regularly check their physical performance in sports-related activities in order to prevent injuries and disorders (Table 1). Based on the results of the medical examination, guidance on adequate training methods and exercises can be provided to ensure safe and more advanced sports activities (Fig. 1). When a major disease or illness is found during an examination, it may become necessary to change the activity or to discontinue it completely in some cases. The items that the medical examination covers vary according to the particular sporting event and the overall activity level demanded.

This paper describes several common items that are evaluated during the medical checkup: (1) An internal medical evaluation to check for

underlying systemic diseases to ensure safe participation, (2) brain surgery and orthopaedic evaluations to check for underlying diseases and to evaluate the strength of the muscles and the supporting tissues in the head and limbs, which are often susceptible to sports-related injuries, (3) physical strength evaluation to check physical performance, and (4) individual checkup items for each person and the utilization and feedback of the data obtained.

Internal Medical Evaluation

During the internal medical evaluation, the greatest care should be taken to check for various forms of heart disease. The presence of heart disease indicates that participation in a sporting activity may lead to the onset of a severe or acute medical condition. Particularly in the case of valvular disease and ischemic heart disease, involvement in a sports activity can induce a life-threatening condition. Therefore a thorough and detailed examination is necessary.

Firstly, the patient should be asked about their past medical history in full detail, including whether they have or have had arrhythmia and hypertension. It is also important to check for a past history of diseases such as rheumatic fever, Kawasaki disease and Marfan's syndrome that lead to heart disease. Cardiopulmonary function should be evaluated by performing auscultation to check for heart murmur and to examine lung field, in addition to examinations such as electrocardiograms, chest X-rays and echocardiography, which should be used when necessary. If possible, detailed examinations with stress tests and Holter ECGs, are even more useful.

As a principal rule, the presence of other diseases that are potentially influenced by sports activities, including renal, hepatic and metabolic diseases, should also be examined. Additionally, during the blood examination, it is necessary to check the hepatic and renal functions and for the presence of anemia as well as the CPK (creatine phosphokinase) levels. Alcohol consumption and smoking should be included as check items as well, because they represent medical risk factors.

Brain Surgery and Orthopaedic Evaluations

In the evaluation for brain surgery, it is necessary to ascertain the patient's past history regarding epilepsy seizures, head injury, cerebral hemorrhage and cerebral infarction. Electroencephalograms, CTs and MRIs should be used when necessary. Patients should be examined thoroughly for the presence of epilepsy and cerebral aneurysm, since these conditions can be fatal in certain sporting events such as boxing if left untreated.[1)]

In the orthopaedic evaluation, the presence of limb injuries including previous bone fractures should be identified. It is also important to inquire about a past history of lower back and neck pain as well as medical conditions related to overuse such as jumper's knee and tennis elbow. Care should be taken when a patient has suffered from previous overuse-related conditions, because they may reappear when sports activities are resumed (even though symptoms are not usually manifested in daily life activities).[2)]

In the diagnosis, a skeletal check should be conducted at first to evaluate the presence of deformations in the upper and lower body limbs, mobility of the trunk, and pain during exercise. Additionally, an extensive examination of the nervous system including muscle strength and perception and reflex activity in each limb, should also be made. For the joints in the limbs, the range of motion should primarily be checked. However, an examination of joint instability is also important, particularly in the knee and ankle joints. Most ligament injuries in these areas do not interfere with daily life, yet they can often cause subjective instability once sports activities are started.

For the cervical and lumbar vertebrae, where

severe sports disorders may occur, and the knee and ankle joints, which are subject to frequent injuries, the presence of deformations or malalignment should be identified during plain X-ray findings. Particularly, plain X-rays can show changes including bipartite patella (which can potentially result in pain during sports activities), os tibiale externum, and in cases where the sports activity has been continued since childhood, Osgood-Schlatter disease and spondylolysis.

For sports that involve a considerable amount of stress applied on the upper limbs, such as baseball and softball, X-ray images of the shoulder and elbow joints should be taken. MRI scans of the cervical and lumbar vertebrae, if possible, will also provide additional relevant diagnostic information. Additionally, electromyograms and CTs are also useful when necessary.

Physical Strength Evaluation

Physical strength evaluation is useful in preventing diseases and enhancing sports performance.[3)] Height, body weight, and body fat ratio are the first items to be measured. A training goal should be established by calculating an individual's optimal body fat ratio, taking into consideration the type of sports they are engaged in, their positions and ages. Some people play sports to reduce body weight and body fat, and regular measurements of these items will help boost their passion and enthusiasm for the sports activity they are engaged in.

Muscle strength in the lower and upper limbs should be separately quantified using a measuring device (Fig. 2). Such measurements not only reveal reduced muscle strength caused by different types of diseases and disorders, but also indicate the degree of muscle strength build-up, which is important for enhancing personal motivation.

The balance with antagonist muscles is also an important factor related to muscle strength.

Fig. 2 Quantification of muscle strength with a measuring device

For example, the balance of muscle strength between the quadriceps and antagonist muscles such as the hamstring has a significant effect on exercise performance. Therefore the strength ratio of these muscles should be checked and subsequently used as a guide for training. For athletes, it is necessary to measure their individual performance in aerobic and anaerobic exercise, and subsequently this data can be used as a guide for training purposes.

Feedback and Data Analysis

The results obtained from these evaluations and examinations should be promptly fed back to athletes, coaches and trainers. Based on the results, athletes may occasionally be forced to stop further sports activities, to change the sporting event they participate in, or to alter the position they play on the team. In such cases, it is essential that physicians inform the individual of his/her results, and they should also discuss the future course of action with the athlete and the coaches and trainers. Additionally, it is important to provide advice from a physician's standpoint.

If the medical checkup reveals a disease or physical drawback that can be coped with, the physician should confer with the athlete, coach

and trainer about the treatment and training methods that are available. The results of the internal medical evaluation should be used in the prevention and treatment of diseases and for nutritional guidance. And the results from the brain surgery and orthopaedic evaluations should be used in the prevention and treatment of each disease and disorder that is diagnosed, and to determine appropriate training methods for medical conditions related to overuse. Data from the physical strength evaluation should be used for controlling body weight and determining the best muscle training method. In this case, it is important to obtain data collected over time in order to ascertain the effectiveness of treatment and training, and to also enhance an athlete's motivation.

Even if a particular treatment or training approach does not yield a 100 percent improvement in the athletes, they can still effectively utilize the results to learn about their shortcomings and weak areas, and thereby master other skills or use alternative methods. In team sports, when a coach or trainer is able to obtain medical and sports performance data for each of their players, it becomes easier to develop plans and team strategy, including the positioning of players.

Additionally, if this prospective data is accumulated and then comprehensively analyzed, it will serve as an information source that can be effectively used to elucidate the causes of sports injuries and disorders as well as how to prevent and treat them.

Conclusion

This paper described the ways in which sports-related medical checkups are implemented and utilized. Both sports athletes and the general public are expected to continue to increase their overall level of athletic ability in the future, with this ability becoming more complex. Simultaneously, it is anticipated that the importance and usefulness of sports-related medical checkups will further increase as well.

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Clinical Approaches for Shoulder Injuries in Sports

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Abstract: Shoulder injuries in sports can be divided roughly into two types, sports related injuries and injuries caused by overuse. For injuries such as dislocation, fracture, and injury of the soft tissues, ordinary treatment is effective and sufficient. However, in the case of overuse, the disorders cannot be healed completely without repairing damaged organic portions, and without a functional analysis of the mechanism by which it occurred. Conventional treatments for the disorders are not always satisfactory, because the rest alleviates symptoms in some subjects, and the symptom reoccurs after the patient returns to the sport. The reason why appropriate treatment is not provided, is the lack of understanding of the disorders by athletes, the people around them, and insufficient correspondence from the medical side. Their chief complaints are mainly pain and instability of the shoulder, however, the complaints can not be evaluated and understood easily with ordinary examinations. In this paper, we will discuss the diagnostic methods and treatments for main shoulder injuries in sports, including rotator interval lesion, tendinitis of the long head of the biceps tendon, infraspinatus tendon lesion, Bennett lesion, and latissimus dorsi syndrome.

Key words: Sports injury; Joint distention; Rotator interval lesion; Latissimus dorsi syndrome

Introduction

Shoulder injuries in sports are divided roughly into types caused by injuries and by overuse. For injuries such as dislocation, fracture, or injury of the soft tissues, the treatment can be traumatologic. However, the cases due to a disorder can be healed completely only when causative pathologic changes are repaired and their recurrence is prevented after the mechanism of the occurrence is elucidated. As for treatment of the disorder, although the symptoms are alleviated by taking rest, they recur after exercising again in many cases. Thus, satisfactory results are not always obtained.

For critical disorders, although there is a pas-

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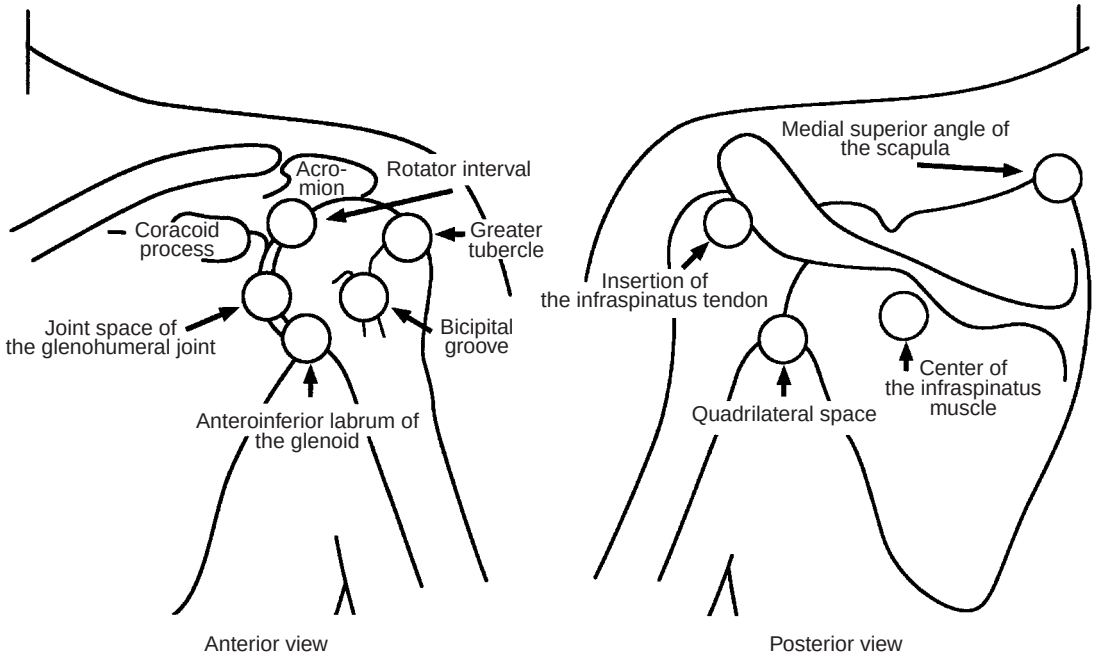

Fig 1 Tender points of the shoulder

sive measure that advises changes in exercise regimen, it is not easy to obtain the consent of the athletes. Even if surgical repair is actively recommended, many athletes reject it because they fear reduced abilities. The reasons why appropriate treatment is not provided are the lack of understanding of the disorder among the athletes and the people around them and inappropriate correspondence from the medical side. As a result, the prevailing notion is that they will not be able to return to their original sports activities if they undergo surgery. What is important is that physicians understand causative lesions accurately, clarify causes of the occurrence at the same time, and build a reliable relationship with the patients by providing them with adequate information.

Diagnostic Methods

The main complaints are pain and instability of the shoulder joint. However, both the complaints are obscure and cannot be understood easily. To deduce a site with a disorder, a tender point is first found (Fig. 1). Anteriorly, the rotator interval, which is prone to injury or disorder, the bicipital groove at which tendinitis of the long head of the biceps tendon is likely to occur, and the greater and lesser tubercles attaching the rotator cuff are investigated, and the joint space is examined for injuries of the glenohumeral ligaments. The posterior outer part of the humeral head is examined for the tendinitis and injury of the infraspinatus tendon. Further, the quadrilateral space where vessels pass through and the medial superior angle of the scapula in which tenderness that is specific to shoulder stiffness may be present are investigated.

It is better to understand the instability under dynamic conditions. First, the upper arm is pulled downward to investigate the downward instability. A typical positive finding is the hollow (dimple) of the deltoid muscle just inferior part of the acromion, and differential diagnosis is made between loose shoulder (multidirectional instability) and rotator interval lesion in which the hollow disappears by

maintaining the upper arm in an externally rotated position. The anteroposterior instability is investigated for the presence or absence of a spring sensation when the humeral head is compressed, or by the apprehension test in which the upper arms are elevated laterally and the humeral head is compressed posteriorly. Moreover, the instability at the upper arm in the elevated position is investigated. The Zero Position test, which investigates the presence or absence of pain that occurs when the upper arm is rotated at the maximally elevated position, is useful in identifying the presence of a rotator interval lesion or obliteration of the subscapularis bursa.[1,2)]

Diagnosis and Treatment

The tendency to diagnose the injury with complex equipment in the beginning should be avoided. CT and MRI images taken under a static condition sometimes do not correspond to actual clinical findings, and false positive results are shown in many cases. The pain block test is a simple method of evaluating a site with pain when an anesthetic is infused to the site and sedated. At the same time, the addition of a small dose of steroids or drugs can have treatment effects. The recommended injection is administered one-finger breadth lateral from the coracoid process toward the subacromial bursa, but not to the bicipital groove because it causes bleeding easily.

An arthrography of the shoulder joint is primarily used as a procedure to diagnose pathologic changes in the joint. However, it can be also be an effective method that alleviates pain.[3)] This method is used to reduce high intraarticular pressure by joint distension. It is based on the phenomenon that "intraarticular pressure changes according to the position of the upper extremities and it reaches the maximum at an upraised position." In particular, the obliteration of the subscapularis bursa is found in 34% of painful shoulders, and the increase in intraarticular pressure induced by this causes severe pain. Due to this, the clinical effects of this method, where a mixture of 10 cc of contrast medium (or physiological saline solution) and 10 cc of anesthetic is infused to the joint and the obliteration of the subscapularis bursa is opened by infusion pressure or movement pressure, are valuable. The most effective motion is forced abduction and internal rotation, and pain relief and improved shoulder function can be obtained immediately after this method is conducted.

Although physical therapy is given priority in conservative treatment, it is important to evaluate pathologic conditions and confirm the treatment effects. Continuously treating patients through aimless surgery should be avoided. Postoperative rehabilitation has a similar significance to surgery.

Shoulder Sports Disorders

Most of the shoulder disorders are due to inflammation caused by overuse or pathologic changes caused by accumulated overuse. Increasing non-specific pain was usually thought to accompany a lesion at the rotator cuff. Subsequently, as the concept of impingement came to the forefront, it was believed for a long time that all sports related pains could be explained by this concept. Recently, however, the idea that many athletes have basic instability and impingement, which is secondary to basic instability, has been gradually accepted. We have experienced that in shoulder disorders in sports, not only do many cases have pathologic changes, but the pathologic conditions are also functional disorders. Pain induced by increased intraarticular pressure and instability due to lack of centripetal force of the humeral head to the glenoid are such cases.

1. Rotator interval lesion

The rotator interval is the space between the subscapularis tendon and the supraspinatus tendon (Fig. 2). It is formed by a thin, elastic, membranous tissue and its function is to make

Fig, 2 Schema of the rotator interval (arrow)

the movement of the upper arm smooth by adjustable extension and contraction. This region directly receives the effect of changes in the intraarticular pressure caused by positional changes of the upper arm or has a structure known as the so-called safety valve. Therefore, injury occurs easily in this area when the athlete quickly returns to an internal rotation position from an excessively externally rotated position like pitching in baseball and spiking in volleyball.

The chief complaint is pain, and severe tenderness is found at the rotator interval in 99% of patients. Severe pain during motion is induced by elevation and external rotation, and this is probably because the intraarticular pressure rises to the maximum in this position and a strong stimulus of intraarticular pressure is added to the rotator interval. Regarding complaints of instability, anteroinferior instability is observed in 90% of the patients. The degree was slight, but a dimple sign is positive in the internal rotation position, disappearing in external rotation because of the fitting of the humeral head to the glenoid. There is instability in the pivotal position, and the slipping phenomenon is found at a high rate of 82%. This lesion occurs mostly in young males due to overuse of the upper arms. A definite diagnosis is made by understanding deviating findings of the rotator interval with a contrast medium on dynamic arthrograms. Because 90% of the patients are healed by conservative treatment, although it is not harmful for them to be treated as distortion or rotator inflammation, when the injury is fresh, it becomes problematic when the lesion is overlooked and left without treatment to become chronic. If a case resists conservative treatment and has persistent symptoms, it is an indication of the need for surgery.[4)]

2. Tendinitis of the long head of the biceps tendon

The long head of the biceps tendon is in the bicipital groove and it controls subtle movements of the humeral head. However, during the throwing motion, sudden rotary force is imposed, friction occurs at the bicipital groove, and a strong traction force is imposed on the attachment site. Moreover, because this tendon holds down the humeral head at abduction at an externally rotated position, and functions as a support mechanism of the humeral head, the shoulder with anteroposterior instability is especially subjected to a strong load.

Tendinitis of the long head of the biceps tendon occurs when an excessive force is exerted on the upper arm, and it is more likely to occur in amateur athletes who perform forced actions of throwing a ball rather than in professional athletes.

3. Infraspinatus tendon lesion

When an atrophy is present in the infraspinatus tendon, the case is diagnosed as entrapment neuropathy of the suprascapular nerve. However, rupture of the infraspinatus tendon occurs in a relatively large number of athletes. This occurs when a strong traction force acts on the upper arm during the follow-through phase of the throwing.

4. Bennett lesion

This is an osteophyte or bony spur on the glenoid described by Bennett — a characteristic changes found in throwing athletes. As for

the development mechanism, the posterior portion of the joint capsule and triceps tendon are pulled due to overuse of the upper arm, and an osteoarthritic change occurs in the attachment site. The brachial circumflex nerve causes a strange sensation and pain, and radiating pain in the deltoid is experienced at times. When pain is present, although inflammation at the concerned site is suspected, conservative treatment is sufficient.[5] This disease, which is seen frequently in throwing athletes, is diagnosed based on radiographic findings. Surgical treatment may cause the instability of the shoulder to occur.

5. Latissimus dorsi syndrome

The latissimus dorsi is a muscle that originates from the 6th to the 12th thoracic vertebrae and ends in the rest of lesser tubercle. It adducts the arm posteromedially, and also participates in its internal rotation by pulling posteromedially. In the posture involving an abduction and external rotation position, such as in the throwing motion, the latissimus dorsi expands and exhibits a strong internal action power like a spring. When the latissimus dorsi contracts, abduction of the scapula and abduction and external rotation of the shoulder joint will be limited, and in consequence, the throwing motion will be hindered. However, most of the patients do not know the existence of this important muscle-tendon function. They only understand this symptom as problematic when lowering the elbow in the throwing form. Since the latissimus dorsi syndrome may be accompanied by the pathologic conditions of shoulder pain and disorder, clinicians should pay attention to the presence of this syndrome due to fatigue.

Conclusion

It is likely that a shoulder disorder is induced by disturbance of the other parts such as an action of the hip joint, knee joint, and ankle joint or the vertebral column. It is impossible for athletes to return to their sports activities even if the shoulder is treated sufficiently, unless they are undergoing integrated treatment. However, finding the responsible lesion by various examinations is given priority so excessively that there are only a few occasions for the mechanism of the occurrence to be analyzed. However, it is important to note that most shoulder disorders due to sports are functional disorders induced by inflammation caused by overuse or prolonged overuse.

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Medical Examination and Treatment for Hand Sports Injuries and Disorders

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Abstract: There are relatively many opportunities to encounter hand sports injuries and disorders in ordinary clinical practice. However, if the selected treatment is inappropriate, a notable disorder may remain. To prevent this, it is important for coaches to understand the significance of primary care and advise the athlete to be treated appropriately at the initial stage. It is also desirable that physicians who regularly examine them provide appropriate treatment at the first examination. In this paper, we will discuss the diagnosis and treatment for sports injuries specific to hands and fingers, and sports disorders requiring surgical treatment.

Key words: Scaphoid fracture; Fracture of the hook of hamate; Mallet finger; Sports disorders

Introduction

Clinically, in hand injuries and disorders, cases due to a single major injury such as falling are likely to display local pain and swelling, and can be treated relatively easily. However, because there are some specific sports related injuries, if the selected treatment is inappropriate, a notable disorder may remain.

However, in the case of the hand, sports disorders that are induced by chronic stimulation such as repetitive minor injuries, do not greatly affect basic actions such as running and jumping in comparison to injuries in other sites. Therefore, such cases are not dealt with since they are not considered to be serious, and the athlete continues to be active in the sport. As for dealing with hand sports injuries and disorders, it is important for coaches to instruct athletes about understanding the importance of primary care sufficiently. It is also desirable that physicians who examine them regularly to provide appropriate treatment during the first examination. In this paper, we will discuss sports injuries specific to hands and fingers, and sports disorders requiring surgical treatment.

Hand Sports Injuries

1. Scaphoid fracture

The scaphoid fracture is the most common fracture of the carpus in sports. This fracture

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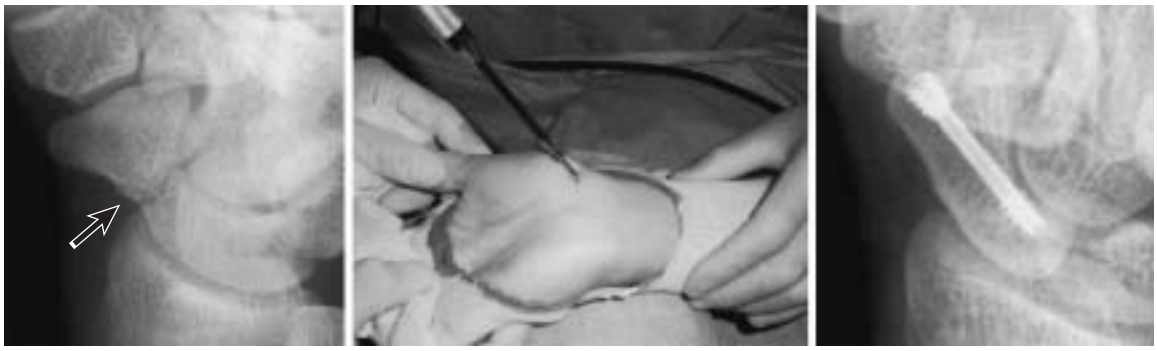

Fig. 1 Scaphoid fracture
Left: Bone fracture shown on radiograms of the scaphoid (arrow = fracture site)
Middle: Osteosynthesis by cuticular cut in a fresh case (DTJ screw)
Right: Postoperative radiogram. A firm compressed fixation is possible.

occurs not only when athletes fall on their outstretched palm, but also occurs when the severe hyperextension and slight radial deviation of the wrist is forced when receiving a pass in volleyball or blocking a shot in soccer. The bone union in a scaphoid fracture is not achieved easily. Because the symptoms at the initial stage are slight, the patient believes this to be a simple distortion and continues playing the sport, consequently inducing pseudoarthrosis. Even if the patient consults a local clinic or hospital, it is unlikely to be diagnosed using the usual radiograms.

Many cases are left untreated, and the patient usually consults a local clinic or hospital after it develops into pseudoarthrosis. Although MRI is useful during early diagnosis when tenderness is present in the scaphoid part, it is important to suspect this as a fracture. In acute cases, conservative treatment is selected for stable cases, and surgical treatment for unstable cases. However, in the case of conservative treatment, the immobilization period with the thumb spica cast is long, i.e., six to eight weeks. Thus, for patients who desire to return to their sports at an early stage, an internal fixation with screws is conducted, and even in many stable cases, the immobilization period is shortened (Fig. 1).

Fig. 2 3D-CT image of fracture of hook of hamate (arrow = fracture site)

2. The fracture of the hook of hamate

A fracture of the hook of hamate is sometimes difficult to diagnose using radiography. Therefore, initial diagnosis can be difficult. This fracture is thought to occur due to repetitive stress to the hook of the hamate from the grip end of a golf club, baseball bat, or tennis racquet. CT is the most useful technique for diagnosing this type of fracture (Fig. 2). In most instances, unless the diagnosis is delayed, union is likely after immobilization, but excision of the fragment may be necessary for nonunion, persistent pain, or ulnar nerve palsy. For patients who desire an early return to their sports activities, excision of the fragment may be indicated.

Fig. 3 Bennett fracture (arrow = fracture site)

Fig. 4 Osseous mallet finger (arrow = fracture site)

3. The fracture of the metacarpal bone or phalanges

In fractures of the metacarpal bone or phalanges, if a severe deformity (especially rotation deformity) is not present, the fracture is treated conservatively in many cases. In intra-articular fractures such as a dislocation fracture of the proximal interphalangeal joints, a dislocation fracture of the carpometacarpal joint of the thumb (Bennett fracture) (Fig. 3), and avulsion fractures at the insertions of tendons and ligaments, a slight dislocation of a bone fragment may interfere with sports activities later. Thus, the fragments should be reduced and fixed internally to restore joint function, tendon or ligament function as well as joint integrity at an early stage in many cases.[1)]

4. Mallet finger

Disruption of the terminal extensor tendon that results in a flexion deformity of the distal interphalangeal joint is commonly referred to as a mallet finger. Among finger injuries in sports, a high incidence of mallet finger is seen in ordinary medical practices. Fractures of the dorsal lip of the distal phalanx are classified into two types according to the fracture pattern. One is the extensor origin type (a small avulsion fracture), which occurs when the terminal extensor tendon is ruptured by a forceful blow to the tip of the finger causing sudden flexion and the other is the bony origin type (larger fracture of 20% to 50% of the articular surface) that occurs in hyperextension injuries of the distal interphalangeal joint (Fig. 4).[2)]

If there is laceration at or proximal to the distal interphalangeal joint with loss of tendon continuity, treatment usually consists of continuous distal interphalangeal joint extension splinting with an aluminum splint for 6 to 8 weeks. For fractures involving more than one third of the articular surface with associated subluxation and dislocation, closed reduction and percutaneous fixation using the Ishiguro method is recomended.[3)]

5. Jersey finger

Jersey finger occurs through action of the

hand being shaken off, notably when athletes grasp an opponent's jersey or pants in rugby or American football. When there is a strong flexion force on the distal interphalangeal joint, a strong external extension force is added to resist the flexion force, and the tendon of the flexor digitorum profoundus is ruptured at the site attaching the distal phalange. The ring finger and the little finger are most frequently injured. Because the fragment usually is small and displaced widely by the pull of the tendon, treatment is directed toward soft tissue avulsion and may consist of open reduction and surgical repair of the terminal flexor tendon using the pull-out method.

6. Skier's thumb

An injury to the ulnar collateral ligament of the thumb metacarpophalangeal joint, commonly referred to as gamekeeper's thumb or skier's thumb, is very common. It is likely to occur during skiing accidents when the athlete falls on an outstretched hand with forceful radial and palmar abduction of the thumb. In this injury, because of the anatomical feature where the ruptured edge of the ulnar collateral ligament may become displaced and folded back on itself beneath the proximal edge of the adductor aponeurosis (Stener's lesion), natural healing may be impossible in some cases. Differentiating between an incomplete and complete rupture of the ulnar collateral ligament is necessary because incomplete ruptures are treated nonoperatively and complete ruptures require surgery.

An injured thumb that demonstrates more than 25 degrees of instability compared to the uninjured side by anteroposterior stress roentgenograms is indicative of a complete rupture. Acute complete ruptures of the ulnar collateral ligament should be treated with surgical repair of the ligament. If the repair is done several months after the injury, a graft can be used to replace the ligament. Recently, the graft using palmaris longus tendon can be threaded through the proximal and distal attachments of the ligament and attached by interference screws (TJ screw system) to reconstruct the ligament. Favorable results have been obtained.[4] Since ordinary living as well as sports activities may be disturbed markedly, early and appropriate diagnosis and treatment is required.

Hand Sports Disorders

1. Injuries of the trianglar fibrocartilage complex (TFCC)

When evaluating patients with painful wrists, it is important to try to anatomically localize the source of the pain. The triangular fibrocartilage complex (TFCC) is the ligamentous and cartilaginous structures attaching the distal ulna to the distal radius and ulnar side of the carpus. Among sports disorders conventionally treated as a distortion of the wrist joints, the injury of the TFCC is one whose pathologic conditions have been clarified recently. The injury occurs due to direct compression or shearing stress between the ulnar head and carpus during sports. The useful diagnostic methods are history, physical examination (ulnocarpal stress test), roentgenography, arthrography and arthroscopy. As for its treatment, the patient is instructed to rest, a splint fixation is attempted to avoid repetitive external force, and conservative treatment is conducted. However, when conservative treatment cannot be conducted due to the unique properties of some sports or because it is ineffective, the condition of TFCC is confirmed under arthroscopy of the wrist joint. Subsequently, synovectomy and a partial resection or repair of TFCC are performed.

2. Ulnar abutment syndrome

Pain at the ulnar aspect of the wrist indicates ulnar abutment syndrome, and it is caused when the wrist joint is used continuously under the condition of ulnar plus variance due to some cause. The abutment of the ulnar head causes pain at this site and TFCC tears and perforations accompany many cases. Treatment,

that aims to improve the ulnar plus variance, the ulnar shortening procedure, radial lengthening, and limited ulnar head excision have been reported. There have been many reports stating that the ulnar shortening procedure, based on the Milch method, is useful for athletes.

3. Scaphoid impaction syndrome and ulnar styloid impaction syndrome

In scaphoid impaction syndrome or ulnar styloid impaction syndrome, when axial pressure is exerted repeatedly at the outstretched wrist joint, the styloid process of radius and the scaphoid dorsal side impact each other to cause pain, or the ulnar styloid process impacts the triquetrum to cause pain. Although conservative treatment is conducted initially, excision of the styloid process and synovectomy are performed for refractory cases.

4. Lunatomalacia (Kienböck disease)

Kienböck disease is a painful disorder of the wrist due to unknown causes where roentgenograms show avascular necrosis of the carpal lunate. In 75% of patients, the disorder is preceded by severe trauma resulting from sports injuries, usually with the wrist in severe dorsiflexion in soccer, volleyball, American football, karate, and other sports. Major complaints are swelling and pain on the dorsal side of the hand joint, restricted range of motion at the dorsiflexion of the wrist joint, and reduced gripping power. CT scanning and MRI may be required to see the disorder. No abnormality may be found on radiograms during the early stages. Some have preferred simple casting if the disease is considered to be quite early (stage I or II, before sclerosis, fragmentation, or collapse occurs). Late stage cases (stage III) are referred for surgical treatments such as radial shortening, radial wedge osteotomy, ulnar lengthening, excision and prosthetic replacement, and revascularization procedure. When secondary arthritic changes have developed throughout the wrist (stage IV), treatment usually consists of proximal carpal row resection or wrist arthrodesis.

Conclusion

We discussed sports injuries specific to the hands and fingers, and sports disorders that require relatively frequent surgical treatment. Hand sports injuries and disorders are encountered in ordinary medical practice relatively often. For athletes, the functional disorders of the hands may advance to a disorder comparative to the disorders of the knee or ankle joints. The disorder should not be regarded simply as a disorder of only one finger joint, but must be treated appropriately, based on an accurate diagnosis. When physical findings such as pain and gripping power do not improve in one to two weeks after the first examination, the patient should be immediately referred to an orthopedic hand surgeon.

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Medical Practice in Lumbar Sports Injuries and Disorders

JMAJ 48(1): 16–19, 2005

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Abstract: In Japan, sports medicine has developed significantly in conjunction with goals to improve athletic levels. Moreover, Japan has become an aging society where promoting health and preventing disease through sports have become commonplace. However, due to the participation by people of all ages in many sports activities, the occurrence of low back pain has increased. Low back pain is classified into several types, and the absence of adequate treatment will have a significant impact on prognosis. Therefore, early and adequate diagnosis of low back pain is very important. When low back pain is caused by sports, the specificity of each sport event should be noted. This paper describes the lumbar sport injuries and disorders such as sprains, fractures of the lumbar vertebrae, disc herniation, spondylolysis, and vertebral end-plate disorder during the growth period. In sports disorders, precise diagnosis and adequate treatment are necessary, and it is essential to avoid continuing treatment aimlessly when symptoms persist.

Key words: Low back pain; Sports injury; Sports disorder

Introduction

In Japan, sports medicine has developed markedly, in conjunction with the goal to improve athletic levels. Moreover, promoting health and preventing disease through sports activities have become commonplace in Japan's aging society. Consequently, maintaining good health through rest, nourishment, and exercise is now assuming a dominant position in daily life, and the significance of sports has become increasingly recognized regardless of age and gender.

More than 60 percent of those who exercise experience low back pain due to damage (injury and disorder) caused by sports. It is important to note that low back pain frequently relapses when the sport is resumed, despite temporary improvement with regular medical treatment.[1)] In many clinical settings, it is difficult to provide treatment that allows the individual to return to the sport.

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Table 1 Important Points in Medical Interviews

- Acute or chronic onset
- Age (growth period, adult, middle-aged, or aged)
- Association with sport activity
- Goals in the sport (current or future)
- Level (athletic or amateur)
- Position in team
- Team conditions
- Team circumstances

Table 2 Conservative and Surgical Therapies

Conservative Therapy	Surgical Therapy
Rest	Reduction and spinal fixation
Medication	Percutaneous discectomy
Thermotherapy	Discectomy
Traction	Laminectomy
Exercise	Spinal fixation
Therapy with orthosis	
Nerve blocking therapy	

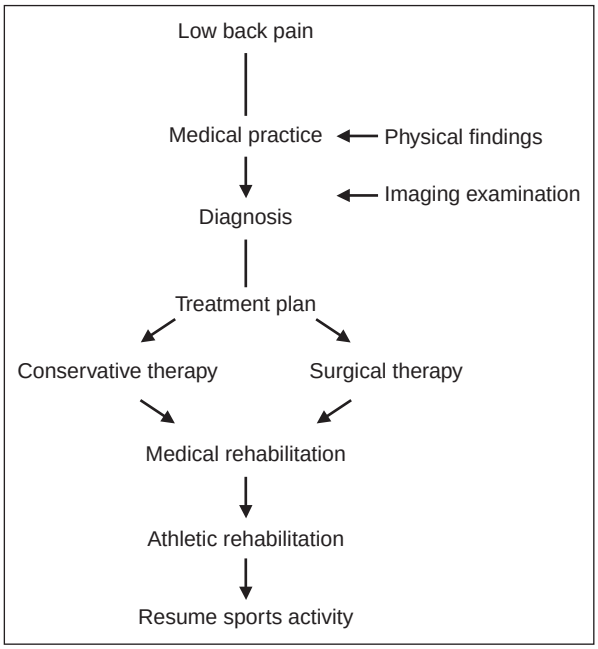

Fig. 1 Diagnostic strategy for low back pain

This paper describes the sports injuries and disorders in the lumbar spine.

Diagnosis

Vertebral damage due to sports is broadly classified as traumatic, where a strong load is applied that forces the vertebrae to move out of the normal motion range, and the non-traumatic, where a repetitive load is applied to the vertebrae within the normal range of motion.[3)]

Diagnosis and treatment of low back pain in athletes must be based on local findings and a medical interview to determine the age, onset condition, and background of the athletes[3)] (Table 1). In particular, low back pain and backache develop frequently in a wide range of ages, from adolescents in their growth period to the elderly, and they commonly lead to major problems when sports activities are continued.[4)] In order for athletes to resume their sports activities, it is necessary to provide treatment in conjunction with the performance level of each athlete[5,6)] (Fig. 1). When symptoms persist or are exacerbated despite conservative treatment, physicians should consider surgical treatment (Table 2).

Lumbar Sports Injuries

1. Lumbar sprains

Lumbar sprains occur as a result of multiple motions including flexion, extension, and rotation such as a sudden twist of the lumbar spine. It results in a small tear (muscle strain) due to over-extension of soft tissues such as muscles and fascia, contusion of an intervertebral joint, or tearing of the interspinous ligament.

The symptoms include severe low back pain and difficulty with body movements in the acute phase and occasionally, local tenderness, purpora, and swelling.

X-rays often show no abnormalities, while in some cases, MRI (magnetic resonance imaging) reveals soft tissue injuries including muscles and fascia.

The treatment of lumbar sprains in the acute phase involves rest, medication with an anti-inflammatory analgesic, muscular relaxants, and icing. Treatment in the chronic phase involves enhancing muscle strength and stretching in the abdomen and back.

2. Lumbar vertebrae fracture

Lumbar vertebrae fractures are caused by a direct force or sudden muscle contraction and are commonly accompanied by major soft tissue damage. The fracture sites are the vertebral arch, spinous process, transverse process, and the vertebral body. Imaging with plain X-rays or a CT (computed tomography) scan is useful for diagnosis. Recently, compression fractures of the vertebral body have been increasing, due to air sports such as hang gliding.. Treatment and prognosis depend on the degree of fracture and the presence of complications.

Symptoms include severe pain (spontaneous or during exercise) in the lower back and difficulty with body movement in the acute phase as well as local bruising, swelling, and occasionally, spinal deformation and neuroparalysis. Therefore, it is essential to check neurological findings (presence of perception, motion, reflex, bladder and rectal disturbance).

Treatment during the acute phase includes rest, medication, and fixation (with plaster and corset). When a burst fracture, dislocation fracture or neuroparalysis is present, surgical treatment is carried out.

3. Lumbar disk herniation

Lumbar disk herniation in athletes is caused by acute or chronic external force. The symptoms frequently relapse even if they are temporarily relieved after conservative treatment, and therefore, it is important to carefully select the treatment. This condition commonly occurs in athletes involved in sports such as baseball, basketball, volleyball, rugby, athletics, table tennis, boat racing, and judo.

The symptoms include pain in the lower back and lower limbs, limited movement of the trunk and in the lower limbs. In patients with limited movement in the lower limbs, careful treatment and follow-up examinations are necessary. As a supplemental diagnosis, plain X-rays, CT, MRI, and myelography are used. In particular, MRI provides extensive data including the type of disk herniation.

The principal treatment during the acute phase includes rest and medication with an anti-inflammatory analgesic and muscular relaxants. Additionally, thermotherapy, traction therapy, exercise therapy, and epidural nerve block are used. When conservative treatment is ineffective, and the symptoms persist and are exacerbated, surgical treatment is recommended. If the opportunity for performing surgery is missed, recovery from paralysis may be difficult. Returning to the sport activity requires systematic athletic rehabilitation.

Lumbar Sports Disorders

1. Spondylolysis

Lumbar spondylolysis commonly occurs as a stress fracture in the growth period when bones are immature. However, top-ranked adult athletes may develop spondylolysis or spondylolisthesis. This condition occurs due to single or multiple movements including hyperflexion, hyperextension, and rotation of the trunk.[7] The sport activities that are frequently associated with this condition are baseball, sumo wrestling, judo, athletics, and gymnastics.

The symptoms include low back pain and indefinite complaints of the lower limb (pain, numbness, and weakness), which appear when exercising. For diagnosis, an oblique view of a plain X-ray is useful, and the CT and MRI are invaluable diagnostic tools.[8]

Although conservative treatments can relieve the symptoms in most cases, surgical treatment is recommended for patients who have no remission or repetitive low back pain. Bone union can probably be achieved with conservative treatment using a corset, when early X-rays show the type of crack that has been

sustained. However, it is difficult to achieve bone union in the case of pseudoarthrosis.

2. So-called "low back pain"

The so-called low back pain is mainly a low back pain symptom that is not accompanied by abnormal X-ray findings or symptoms in the lower limbs. Acute and chronic stress causes inflammation in the muscles, ligaments, and fascia, secondary reflex muscle spasms, chronic muscle fatigue, and disturbed blood flow. There is a high incidence of this condition in both athletes and exercisers.[5)]

3. Disorder of the vertebral end-plate during the growth period

The vertebral body in adolescents during their growth period has a ring apophysis unlike that of adults, resulting in the fusion of the secondary ossification center in the 20–29 age range. Igata, *et al.*, classified this disorder into three stages — the early stage (radiolucent lesion), the advanced stage (isolated and segmented lesion), and the end stage (dissecting lesion). The changes in the end stage are marginal separation of the vertebral body in the anterior area, posterior chamber angle separation in the posterior area, and diffuse type and local type separation in the middle area.[9)] The sports that are associated with this condition are the same sports that cause lumbar disk herniation.

In some patients, this condition starts with severe low back pain, and body movement becomes difficult in the acute phase. However, in other patients, it frequently becomes chronic. Imaging examination is necessary for diagnosis, but there is a need to differentiate it from spondylolysis in some cases. Conservative treatment is primarily used.

Conclusion

Recently, in Japan, a variety of sports intended to improve athletic levels and health have become commonplace for school age children to middle-aged or elderly adults. Simultaneously, the number of sports injuries has increased.

Precise diagnosis and adequate treatment are necessary for sports injuries and disorders. When symptoms persist, it is essential to avoid continuing treatment aimlessly.

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Medical Practice for Sports Injuries and Disorders of the Knee

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Abstract: The knee joint is the central weight-bearing joint of the lower limb, where various types of injuries and disorders are caused by sports. This paper summarizes recent topics on typical sports injuries, forcusing on those occurring in the anterior cruciate ligament and meniscus. Anterior cruciate ligament injury often requires surgical treatment, because the instability after the injury seriously interferes with sports activities due to its very poor healing potential. In diagnosis, manual tests such as the Lachman's and pivot shift tests are important. To return to the strenuous pre-injury activity level, ligament reconstruction is necessary. Meniscal injury occurs in relation to sports activities in the younger athletes at a high rate. The patients have symptoms that include pain, catching, and locking. Care should be taken in the meniscal tear accompanied by anterior cruciate ligament injury. In principle, treatment is concerned with the functional preservation of the meniscus, i.e., meniscal repair. However, with this treatment, it takes a longer duration of time for the athlete to return to his sport, and concerns such as healing failure and re-tear remain.

Key words: Anterior cruciate ligament injury; Meniscal injury; Articular cartilage; Recurrent dislocation of the patella

Introduction

The knee joint is the central weight-bearing joint of the lower limb, where various types of injuries and disorders are caused by sports.

In this paper, both injuries and disorders are referred to as injury. This includes anterior/posterior cruciate ligament injury, medial/lateral collateral ligament injury, meniscal injury, articular cartilage injury, recurrent dislocation/subluxation of patella, and a number of chronic conditions such as overuse syndrome. An accurate differential diagnosis of each injury is essential. Minimally invasive arthroscopic surgery has been established as standard treatment for these injuries.

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This paper reviews the injuries and their recent topics, focusing on the anterior cruciate ligament injury and meniscal injury as typical sports injuries.

Anterior Cruciate Ligament Injury

Anterior cruciate ligament injury is the most frequently known sports injury, where healing mechanisms hardly work. Many cases of this injury require surgical treatment due to remaining instabilities that greatly trouble athletes in their sports activities. These instabilities are the most important problem among sports-related knee injuries.[1)]

1. Injury mechanisms and symptoms

The anterior cruciate ligament injury occurs at the moment of jumping, landing, or quick turning with mid-range knee flexion. It also occurs when the knee is excessively rotated during a landing while skiing with the foot remaining fixed to the ski. Many patients say that they heard their knee joints "pop" when they were injured. The pain, which gradually increases after the injury, is severe enough to force most patients to discontinue the activity and visit a medical institution on the same or next day.

Through follow-up, the pain is relieved to the point where the patient has no trouble in daily life, but it is difficult to continue sports activities because of the unstable knee joint. If the patients continue their sports activity, re-injuries will mostly occur and cause a combined injury of the meniscus and the articular cartilage. Thus, such patients complain about the pain due to these injuries as well as the instability.

2. Diagnosis

Since most patients experience the above mentioned injury mechanism, a detailed interview about the mechanism and the history of symptoms will often be helpful in its diagnosis. In cases of acute injuries, the severe haemo-

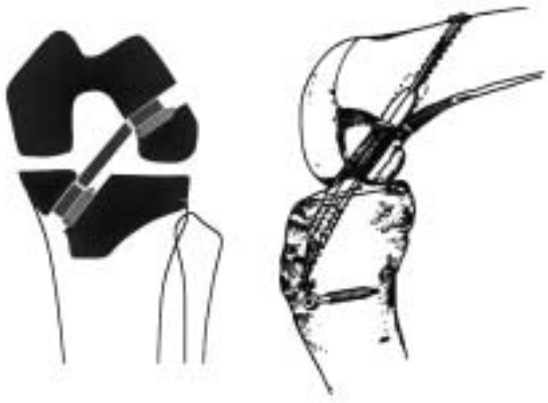

Fig 1 ACL reconstruction using the patellar tendon (left) and the hamstring tendon (right)

arthrosis can be frequently seen at the initial visit.

The most sensitive manual testing is the anterior drawer test with mid knee flexion (Lachman's test), where the results are positive in most cases of injury except acute cases with severe pain. The pivot shift test is also an important manual test that reproduces the functional rotatory instability.

In actual pivot shift tests, axial load as well as valgus and internal rotation force is applied to the fully extended knee, and then the knee joint is passively flexed. If the anterior cruciate ligament insufficiency is serious enough to cause tibial anterior and internal rotatory subluxation, rapid tibial reduction can be observed with knee flexion. The grade of the pivot shift test correlate with the clinical symptoms to some extent. MRI and diagnostic arthroscopy are important in the diagnosis of complications but are not essential for diagnosis of anterior cruciate ligament injury.

3. Treatment

Generally, the conservative treatment of the injury is not likely to cure the instability. In inactive or elderly cases, conservative treatments with muscle exercise and limitation of activity may be effective. Patients need ligament reconstruction to return to the strenuous pre-injury activity level.

Ligament reconstruction usually needs autotransplantation of the patellar tendon or hamstrings (Fig. 1). Arthroscopic surgery has become a standard operation, and surgical techniques are becoming minimally invasive. It is now possible to fix the graft to the appropriate anatomical site.

Recently, anatomical two-bundle reconstruction, which uses double-bundle grafts, has been performed aimed at reproducing physiological constraint of the anterior cruciate ligament. Further reports on this method are anticipated.

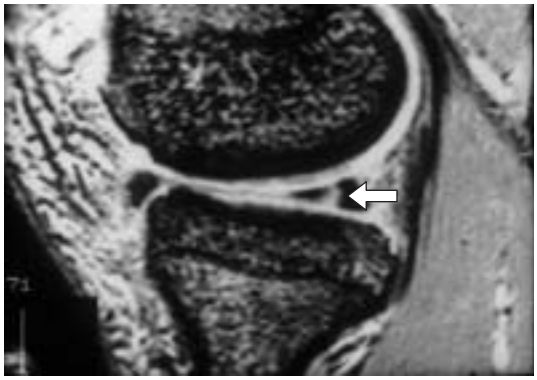

Fig 2 MRI finding on medial meniscal tear

Meniscal Injury

The meniscus is a fibrous cartilage tissue located between the femur and tibia in the knee joint. It is associated with load transmition, shock absorption, and stability of the joint.

Meniscal injury frequently occurs especially among young people during sports activities. Its treatment requires a consideration of degenerative changes in the future even after treatment.

1. Injury mechanisms and symptoms

The mechanism of meniscal injury has been considered attributable to the combination of flexion and rotation of the knee. In young people, such external forces are frequently generated in sports activities. In middle-aged and elderly people with degenerated knee joints, minor injuries or undetectably slight external forces may cause the injuries. In the diagnosis of such people, meniscal injury should always be considered.

Most of the sport-related meniscal injuries are accompanied by anterior cruciate ligament injuries, and most patients complain of instabilities from anterior cruciate ligament insufficiency and pain due to meniscal injuries. In the early stage of meniscal injury, a symptom called "catching" is observed; thereafter, the rupture develops into a state called "locking," in which the full extension of the knee joint is impossible.

2. Diagnosis

In the diagnosis, it is essential to have the complete medical history of the patient. The important physical findings are quadriceps atrophy, tenderness consistent with the joint space, and pain in the hyperextended and hyperflexed knee. Manual tests for meniscal injury such as the McMurray test are also important.

Although quadriceps atrophy is not a specific finding for meniscal injury, it is observed in most of the clonic stage of this injury.

In addition to the traditional manual tests, the authors reported the usefulness of the pivot shift maneuver to diagnose meniscal injury, by observing the location of pain and click in the knee.[2] Arthrography was often used as an auxiliary method to diagnose meniscal injury, but is no longer used, because the maneuver is invasive and its accuracy in the diagnosis of lateral meniscal injury is very low.

On the other hand, thanks to advanced equipment for the MRI, the diagnosis rate of injuries in the meniscus as well as ligaments and cartilage has markedly improved (Fig. 2).

3. Treatment

Since the functions of the meniscus are important, the principle of treatment is functional preservation of the meniscus by meniscal

Fig 3 Diagram of the inside-out meniscal suture technique

repair. Thus, the meniscus should be resected only if repair is impossible. Accordingly, meniscectomy is indicated for tears near the free edge of the meniscus or peripheral tears with severe degeneration or complex tears in the meniscal body.

Meniscectomy, in principle, resects unstable parts and preserves as much of the meniscus as possible in a stable and smooth shape without any major injury. Therefore, a total meniscectomy is not recommended unless total degeneration or severe damage of the meniscus is found. Instead, partial meniscectomy should be performed in most cases. Improved techniques and instruments have enabled surgeons to perform almost all meniscectomy arthroscopically. Generally, partial meniscectomy can accomplish recovery in a short time, but it should be noted that some patients take more time than expected to return to strenuous sports activities.

In most cases, meniscal suture can be performed arthroscopically. Suture methods can be classified as follows: inside-out method, where the surgeon directs the suture thread from the inside to the outside of the joint (Fig. 3); outside-in method, where the surgeon directs the suture thread from the outside to the inside of the joint; and the all inside method, where the surgeon performs all operations inside the joint. Most of the tears can be sutured by the inside-out method, but the outside-in method is suitable for sutures in the anterior segment. The all inside method is suitable for the posterior segment including the posterior horn.

Theoretically, meniscal suture is an excellent method of preserving the meniscus. The patients who underwent the treatment, however, cannot return to their sports activities for a long period of time, and the possibility of healing failure and re-tear remains.[3)]

Other Topics

1. Articular cartilage injury

Injury of the articular cartilage is difficult to diagnose and treat to the extent where the patient can return to their sports activities. In treating this injury, many problems remain unsolved. The basic and clinical studies on autologous osteochondral graft such as mosaicplasty[4)] and autologous chondrocyte implantation have recently provided new research topics. However, long-term clinical results are still needed, and their efficacy remains obscure. Therefore, it is necessary to study their efficacy in comparison with the microfracture technique and the abrasion technique, which are comparable to the conventional drilling technique.

2. Recurrent dislocation and subluxation of patella

For the treatment of recurrent dislocation and subluxation of patella, reconstruction of the medial patello-femoral ligament as well as the traditionally reported proximal realignment and medialization of tibial tuberosity are considered to be efficient.

Conclusion

This paper has presented an outline of the

topic of sports injuries of the knee. Accurate diagnosis and treatment are essential for patients to return to their sports activities. Hopefully, less invasive treatments will be developed in the future.

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Medical Practice for Sports Injuries and Disorders of the Lower Limb

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Abstract: Among sports injuries and disorders of the lower limb, ankle sprains are the most common, followed by ruptures of the Achilles tendon and muscle strains (especially the gastrocnemius muscle). The basic procedure primarily used in the acute phase of injury is well known as RICE: Rest, Icing, Compression, and Elevation. Adequate treatment should be given after precise evaluation of the degree of injury. Disorders such as stress fractures, shin splints (fatigue periostitis), plantar aponeurositis, and painful os tibiale externum, are generally due to overuse and malalignment of the lower limb. After precise diagnosis based on history taking, clinical symptoms, X-ray, bone scintigraphy, and magnetic resonance imaging (MRI), various ways of treatment—for example, rest, arch support, and taping—reduce the local load and contribute to recovery. Meanwhile, in order to engender a smooth return to sports activities and to prevent relapse, stretching, muscle training, taping, and malalignment correction using arch support are all important factors for recovery from injuries and disorders.

Key words: Ankle sprain; Rupture of Achilles tendon; Stress fracture; Shin splint

Introduction

According to the "Survey on Sports-related Injuries,"[1] 88,531 athletic injuries and disorders occurred in 1996 — 16.8% (14,910) - ankle, 6.9% (6,144) - lower leg, 4.4% (3,911) - foot, and 3.3% (2,940) - Achilles tendon related. In the ankle joint, sprains accounted for the most incidences (67%), ligament damage 15.9%, and fractures 11.7%. Muscle strains and fractures in the lower leg occurred with similar incidence, as did sprains and fractures in the foot. As for the Achilles tendon, ruptures accounted for 95.4% of the injuries. This paper will illustrate typical pathological conditions of both sports-related injuries and sports-related disorders.

Sports Injuries of the Lower Limb

1. Ankle sprain

Ankle sprains are the most frequently experienced sports injuries, and the great majority

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Fig. 1 EVERSTEP®6

of cases are inversion sprains caused by forced ankle inversion. The anterior talofibular ligament is typically damaged, as well as the talocalcaneal ligament in severe cases; the posterior talofibular ligament is rarely damaged. When encountering such patients, the first step is to confirm by X-ray that there is no damage of the bone — if in case there is bone damage, adequate procedures should be carried out. Ankle sprains are classified into three grades. In the first degree (mild), the patient complains of mild pain and the physician finds mild swelling, mild joint instability, and no limited range of motion. In the second degree (moderate), all the above is found to be moderate. A completely ruptured ligament would be classified as the third degree where stress X-rays reveal a 10-degree difference or more of the ankle joint inclination (the angle between the tibial and talar articular surfaces) between the normal and affected sites.

The principle procedure to be followed in the acute phase is known as RICE; minimization of swelling, rest, icing, compression, and limb elevation should immediately be conducted after sustaining the injury. If there is severe pain, crutches may be used to bear the weight. Taping, bracing, plastering should be done to prevent future varus alignment.[2] Figure 1 shows a brace used to prevent varus malalignment of the ankle joint (EVERSTEP®6, NIPPON SUGMAX Co., Ltd).

Surgical treatment is rarely necessary for fresh injury cases. For neglected cases in which instability and/or pain persist due to inappropriate initial treatment, taping for varus prevention, fibular and anterior tibial muscle training, and furthermore maintaining dorsiflexion and valgus mobility are all important to limit varus instability during sports activities.

2. Rupture of the Achilles tendon

The Achilles tendon is the largest tendon in the human body and ruptures due to sudden contraction of the gastrocnemius muscle. In younger patients, blood flow disturbance (causing a miniscule rupture) and Achilles tendonitis are common causes, while degeneration of the tendon and inadequate warming up may lead to ruptures in the middle-aged population.[3] The condition is generally associated with volleyball, basketball, gymnastics, tennis, and badminton, in which jumping, landing, forceful stepping, and cutting movements are routine movements. Patients describe the sensation at the moment of rupture as being "kicked from behind," and often times hear a rupturing "pop." Pain is mild in most cases; patients can walk flat-footed, but cannot tiptoe. A recessus can be felt at the ruptured site, and the patient complains of tenderness. When the calf is grasped with the knee joint flexed at 90 degrees in a prone position, the ankle joint normally flexes, but this does not occur with a ruptured Achilles tendon (Thompson's squeeze test).

Emergency treatment involves immobilizing the lower leg with the ankle flexed (so that the stump of the ruptured tendon is not dislocated), icing, and using crutches in order to reduce the weight on the injured leg.

Treatment is globally classified into two groups: conservative therapy (i.e. with a cast or

orthosis) and surgical therapy. The former has many advantages — no scar, no hospitalization, and no concern for any complications (especially infection) — and disadvantages — longer use of crutches for partial weight bearing, delayed recovery of muscle strength, and a longer period of recovery before being able to return to athletic activity. Thus, conservative treatment is generally chosen for patients with relatively stationary jobs, for earlier return to work, and for those who cannot stay in the hospital; on the other hand, surgical treatment is recommended for patients who want an earlier return to sports activities.

If one chooses conservative treatment, the lower leg should be placed in a cast for several weeks with the ankle joint flexed. Next, an ankle foot orthosis should be worn to control the dorsal flexion angle of the ankle. In surgical treatment, the Achilles tendon is sutured, and afterwards the lower leg is put in a cast. After removal of the sutures, an ankle orthosis is worn; full weight bearing is permitted four weeks postoperatively. Most patients return to their usual sports activities four to five months after surgery.

3. Muscle strain of the gastrocnemius muscle

Muscle strains are defined as the condition associated with the rupture of muscle fibers, a partial one in most cases. Often times called a "tennis leg," this well-known condition occurs due to rapid extension of the gastrocnemius muscle (when the ankle is suddenly dorsiflexed from a plantarflexed position), and is induced by a sudden dash or quick turn (as in a tennis serve).[4] The muscle strain is localized at the muscle-tendon interface of the medial head of the gastrocnemius. The patient describes the moment of injury as being "kicked from behind," and hears a rupturing sound. Local tenderness and pain on extension contribute to a fairly easy diagnosis.

Conservative treatment is principally preferred. The basic treatment in the acute phase, RICE — minimization of swelling, local resting, icing, compression, and limb elevation — is necessary immediately after injury and thereafter, when crutches are used to bear the weight.

Sports Disorders of the Lower Leg and Ankle

1. Stress fractures

A stress fracture is a condition where slight external force, repetitively applied to the same area, leads to a bone fissure. This is unlike a regular fracture which is due to a great external force applied at one given moment.

The most common site of a stress fracture in the lower leg and ankle is the tibia, followed by the metatarsi, the fibula, and the navicular bone.[5]

The peak age of onset is 16, followed by 15 and 17; this may be explained by the fact that junior and senior high school students receive physical training similar in level to adults despite their immature physical stature, lower muscle strength, and lesser degree of endurance. Thus their training is apt to be excessively demanding on their skeletal bones. The reason why the peak age is 16 may be that the intensity of exercise sharply increases when junior high school students are enrolled in high school.

Sports associated with this condition include long-distance track which demands continuous running, and basketball which requires repetitive jumping.

A stress fracture of the tibia is commonly the sprinter type, in which a fracture line of the callus is seen at the posteromedial side of the proximal and distal third of the tibia, and the jumper type, in which the bone remodeling layer (fracture line) is detected in the anteromedial third. The latter is refractory, and if conservative treatment is ineffective, surgery may be required including bone grafting. Other common stress fracture sites include the second and third metatarsi and the proximal (jumper type) and distal (splinter type) third of the fibula.

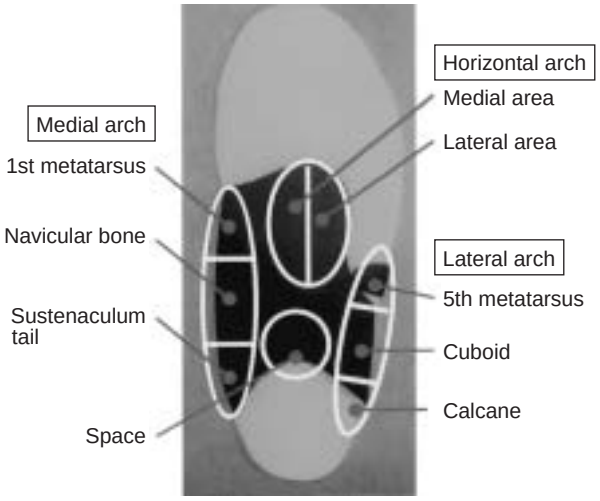

Fig. 2 Arch support used by Kanto Rosai Hospital

This condition should be considered when patients complain of local pain during exercise despite the absence of an apparent injury. An X-ray taken immediately after injury generally reveals no abnormal finding. When a stress fracture is suspected of because of the presence of local pain, even if no abnormal finding is noted at the initial medical examination, a second X-ray should be taken after two weeks. X-ray findings include periosteal reaction in the early phase, followed by bone cortex thickening and osteosclerosis. When an X-ray reveals no abnormal finding, bone scintigraphy and MRI are useful for an early diagnosis.

In most cases, local resting leads to remission of the symptoms. However, patients with a refractory jumper-type fracture of the tibia may need surgical treatment.

To return to sports activities smoothly and to prevent relapses, it is important to follow step-by-step care via morphology evaluation of the ankle, pain induction by weight-bearing, and movement analysis with an F-SCAN (a system for measuring plantar pressure distribution) to evaluate the condition. This should be followed by arch support, taping, enhancement of muscle strength, stretching, and instruction on the right shoes to wear.[6)]

Figure 2 shows the arch support used in our hospital.

2. Shin splints

Shin splints are also known as fatigue periostitis. They are accompanied by pain while running at the attachment of the soleus muscle in the posteromedial distal third of the lower leg. Malalignment (i.e., pes planus) may be a common reason for this condition. Though an X-ray examination may reveal no abnormal finding, in other cases, it may show cortex thickening and bulging of the bone at the medial side of the tibia.[7)] Bone scintigraphy only shows mild accumulation, while clear accumulation is revealed in a stress fracture.[8)] Treatment includes local resting and arch support (especially to reduce weight bearing at the pain site in a patient with pes planus).

3. Plantar aponeurositis

The plantar aponeurosis covers the whole sole of the foot from the calcaneus to the proximal phalanges, and is involved in shock absorption and kicking off, much like a spring.[9)] Athletes who are involved in sports that require continuous running such as long-distance track, frequently develop this condition. Pain appears in the medial plantar surface around the heel while running, landing, and starting to walk first thing in the morning. Local rest, stretching, and arch support (in case there is malalignment) are common ways to treat this condition.

4. Painful os tibiale externum

Os tibiale externum is a sesamoid bone that exists medial to the navicular bone and is found in 10–20% of the population; if a patient complains of local bulging, tenderness, flaring, and swelling, the condition is called "painful os tibiale externum." Diagnosis is not difficult since the accessory bone is seen in X-rays. Examples of treatment procedures include local rest, taping, and arch support (for a pronated foot).[10)]

Conclusion

In this paper, typical sports injuries and disorders of the lower leg and ankle have been described. The basic procedure in the acute phase is known as RICE. Adequate treatment should be given only after the gravity of the injury has been assessed. Since these disorders are commonly due to overuse and malalignment of the lower leg, after precise diagnosis — based on history taking, clinical symptoms, X-ray, bone scintigraphy, and magnetic resonance imaging (MRI) — various ways of treatment (rest, arch support, and taping) reduce the local load and contribute to recovery.

For a smooth return to athletic activities and in order to prevent relapse of injuries or disorders, stretching, enhancement of muscle strength, taping, and correction of malalignment with arch support are all indispensable measures.

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A Summary of the Epidemiologic Surveys on Kawasaki Disease Conducted over 30 years

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Key words: Kawasaki disease; Epidemiology; Nationwide surveys

Introduction

Kawasaki Disease (acute febrile mucocutaneous lymph node syndrome) is a childhood disease that is prevalent in Japan, and causes coronary aneurysms. Dr. Tomisaku Kawasaki first described this disease in Japan in 1967. In 1970, the Japanese Ministry of Health and Welfare organized the Japan Kawasaki Disease Research Committee to investigate its epidemiologic features, causes, pathological features, and treatment. This committee established diagnostic guidelines for Kawasaki Disease that were used in nationwide surveys that were subsequently conducted. Since then, a total of 16 surveys have been conducted every two years and the 17th survey was conducted in 2003. These nationwide surveys have high response rates and they are highly reliable. In addition to these surveys conducted by the Research Committee, many epidemiologic studies have been conducted. Thus, an enormous amount of data has been collected in Japan. Although the cause of this disease remains unknown, any etiological hypothesis that is advocated in the future will need to fully account for the epidemiologic findings. The findings collected over 30 years were summarized in a book[1] that was published in 2002 (English version in 2004[2]). This paper presents some of the epidemiologic features of Kawasaki Disease described in the book.

1. Changes in the number of patients over time

The annual number of patients registered in Japan according to the nationwide surveys is shown in Fig. 1. The number has tended to increase annually and there have been three epidemics, occurring about once every three years. An outbreak is called an epidemic in epidemiology even for non-infectious diseases like Kawasaki Disease. The 1982 epidemic was the largest, involving nearly 16,000 children. Although no further epidemic has occurred since 1986, the gradual increase in the annual number of patients has resumed. In 2000, the number of new cases exceeded 8,000, and this number was ranked third after the first epidemic in 1979. The recent annual incidence

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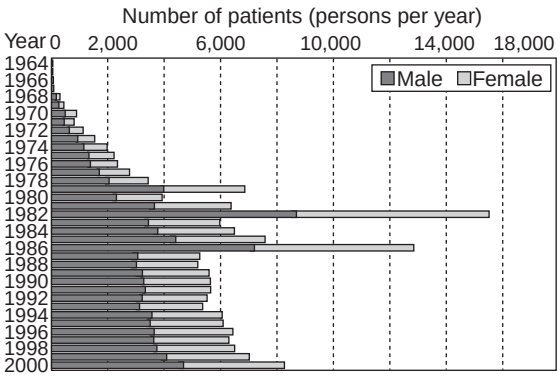

Fig 1 Histogram of the number of patients stratified by year and sex (cited from Reference 2)

rate of Kawasaki disease in children younger than 5 years old is about 140 per 100,000. At each primary school, there will be as many as four pupils for every 600 students who have had a history of Kawasaki Disease. About 170,000 cases of Kawasaki Disease have been reported to date and the number is expected to reach close to 190,000 by the end of 2002. Unreported cases may correspond to about 15% of the total.

2. Age, sex, and recurrence

Patients between the ages of 6 months and 4 years account for about 80% of the total, with a peak in children aged 6 to 12 months, and this pattern has remained unchanged over 30 years. Although rare, Kawasaki Disease has been diagnosed as early as 20 days after birth. Kawasaki Disease has been reported in adult, patients of up to 43 years old who have developed the disease, so it is not necessarily a childhood illness. The sex ratio is constant, with a male-to-female ratio of about 1.3 : 1. Overall, Kawasaki Disease causes coronary lesions about 1.4 times more frequently in male patients, and the incidence of giant aneurysms is about 2.3 times higher in males. Kawasaki Disease recurs in about 3% of the cases, most frequently within 2 years after the initial episode, but rarely after 10 or more years. Patients with up to 5 recurrences have been reported.

3. Other epidemiologic features

The first epidemic in 1979 began in Kyushu and spread to Hokkaido like the flowering pattern of cherry blossoms. In the interim, Kawasaki Disease epidemics occurred in some areas and spread to adjacent regions. This clustering in time and space is characteristic of Kawasaki Disease. Many other characteristics have been clarified by the epidemiologic surveys and these are listed in Table 1.

4. Treatment, incidence of coronary sequelae, mortality, and incomplete type

The principal lesion of Kawasaki Disease is systemic vasculitis. In both Japan and the United States, Kawasaki Disease is the leading cause of acquired heart disease in children. According to the nationwide surveys, immunoglobulin (an immunomodulator) is currently the most common treatment for the disease. Intravenous immunoglobulin (IVIG) was given to about 85% of all patients. Because the efficacy of IVIG is dose-dependent, the total dose for this disease has been recently higher than the usual dose of 1 g/kg, and about 2 g/kg were used in about 70% of the patients. The number of institutions where the total dose was given as a more effective single infusion (instead of divided doses over 5 days) has tended to increase. Coronary lesions occurred during the acute phase in about 18% of patients, a reduction to about half the rate of earlier years when the mainstay treatment was aspirin. The case-fatality rate was initially 2%, and has decreased to the current rate of about 0.1% due to progress in treatment and management. Suspected cases (incomplete Kawasaki Disease), which do not satisfy the major diagnostic criteria, account for about 10% of all cases, and coronary lesions have also been reported in incomplete cases.

5. Prognosis

The long-term prognosis of Kawasaki Disease is unknown. Even patients without coronary sequelae are supposed to be at some risk of

Table 1 Summary of the Epidemiological Features Clarified to Date (cited from Reference 2)

1. Area
   - Localized simultaneous epidemics in various countries throughout the world
   - Geographic shift of the epidemic and chronological clustering
   - Clustering of areas of high incidence (indicative of a close relationship with the movement of people)
   - Frequent epidemics at the local level
   - Simultaneous incidences in adjacent areas
   - Difference in morbidity rates between northern and southern areas is ambiguous (but the rates tend to be low in southern Kyushu and Okinawa)
     Clear-cut differences exist between northern and southern areas for many infectious diseases
   - In-hospital incidence is rare (only about 3 have been reported)
   - Morbidity rate is high in Japan in comparison to neighboring countries
   - In the 1980s, the morbidity rate was high among Hawaiians of Japanese ancestry (3 times the expected value)
   - Many severe cases found in young Caucasian boys
2. Chronological features
   - Almost no incidences noted before 1960
   - Recent tendency for increase in incidences (the incidence rate in 2000 was the third highest)
   - Epidemics on a nationwide scale (in 1979, 1982, 1986)
   - Seasonal characteristic: peaking from March to May
   - Seasonal occurrence in isolated islands independent of the time of epidemic (Miyakojima: December 1980 to January 1981)
3. Sex/Age distribution
   - Sex ratio for the risk of developing the disease: male/female=1.3; risk for recurrence=1.1; risk among siblings=1.1
   - Morbidity rate peaks 6 months after birth, after which it decreases with age
   - Decreases in the age and sex ratio of patients during epidemics
   - High incidence of cardiac sequelae and mortality among males and young infants (particularly those under 6 months)
4. Familial occurrences
   - Risk of siblings contracting the disease during an epidemic: at least 10 times higher than in general population (1% of all patients are siblings)
   - Many cases (at least 50%) occur among siblings within a week of each other
   - For many cases involving siblings, 72% occurs first in the older child
   - Siblings or parents suffer from cold-like symptoms before or after the development of the disease in the family
   - Fatality rate among siblings is high (3 times the average)
   - Frequent family history of tonsillitis, eczema, conjunctivitis, allergic rhinitis, and urticaria in the affected family
   - Abnormal health condition of the mother during pregnancy (e.g., tonsillitis and the use of medication)
5. Environmental factors
   - Fatigue and changes in environment (travel, swimming in a pool, moving to another home, and having guests), which may trigger the disease
   - Type of housing, number of floors, age of building, and the use of air conditioner have no effects
   - No effects exerted by indoor pests (number of ticks or tick layer) or the presence of domestic pets
   - No effects from insecticides or detergents
   - No effects from parents' occupations
   - Carpet cleaning (results observed in the United States)
6. Dietary habits
   - No effects from the type of infant nutrition or milk given
7. Medical history
   - History of frequent contract of cold or allergic rhinitis
   - History of upper respiratory tract infection prior to onset
   - No history of taking any specific medication prior to onset
   - No relationship with inoculation history
8. Recurrence
   - Recurrence observed in 3% of patients; recurrence often noted within 2 years of the first episode
   - Frequent recurrence among some siblings
   - Recurrence rate among siblings is higher (3 times) than among overall patient population
   - Recurrence rate during an epidemic is at least 6 times that of the morbidity rate during the same period
   - Fatality among recurrent cases is high (3 times the average)

developing juvenile coronary athelosclerosis. More than 40,000 patients with Kawasaki Disease have already reached adulthood. Because the highest incidence of this disease is found in Japan and it was detected by a Japanese pediatrician, the world has expected Japanese researchers to clarify the prognosis. Accordingly, it is very important to continue the epidemiologic surveys. The latest diagnostic guidelines and photographs showing features of the Kawasaki Disease are available at the Kawasaki Disease website (http://www.kawasaki-disease.org).

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Epidemiology of Obesity in Japan

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Abstract: According to the 2000 National Nutrition Survey conducted in Japan, the percentage of overweight adults (body mass index [BMI]≥25) was 26.8% among men and 21.3% among women, while the percentage of obese persons (BMI≥30) was 2.2% for men and 3.5% for women among Japanese adults aged 20 years or older. In contrast, the percentage of underweight adults (BMI<18.5) was 4.8% for men and 10.3% for women, with the percentage of underweight individuals especially high among women aged 20–29 years (24.2%) and 30–39 years (17.5%). A comparison of the percentages of overweight adults in 1980, 1990, and 2000 revealed an increasing trend among men regardless of age group. This tendency was more marked in towns and villages than in large cities. Among women aged 20–49 years, the percentage of overweight individuals tended to decrease, with a marked increase noted in the percentage of those who were underweight. This tendency was more distinct in large cities than in towns and villages. Thus, Japanese women presented a contrasting picture of obesity and underweight. A large-scale cohort study done in Japan found a U-shaped dose-response relationship between BMI and all-cause mortality. The figures for all-cause mortality were lowest for men when BMI was 23.0–24.9 and for women when it was 21.0–22.9.

Key words: BMI (body mass index); Overweight/obesity; Underweight; All-cause mortality

Introduction

In order to evaluate obesity, a comprehensive assessment of body composition, distribution of body fat, partitioning of nutrient storage, energy intake, and energy expenditure is necessary.[1)] However, this paper focuses on body composition alone, with the method of assessment limited to the calculation of body mass index (BMI): BMI = (body weight [kg])/(height [m])^2. Measurement of height and weight is easy, inexpensive, and accurate, and highly accurate values can be obtained even through self-reporting. The reproducibility of such data is also adequate to allow useful comparison of differences between groups of people and between annual changes in a particular group. BMI is strongly correlated with total body fat

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as determined by densitometry or skinfold thickness, whereas its correlation with height is low.[2] Accordingly, BMI plays a central role in epidemiologic studies of obesity in adults.

This paper describes the percentage of overweight adults (BMI≥25.0) in Japan and annual variations in this percentage on the basis of data from national nutrition surveys conducted by the Ministry of Health, Labor and Welfare. Large-scale cohort studies on BMI and mortality from all causes are also reviewed. It is a well-established concept that obesity is associated with cardiovascular risk factors (e.g. hypertention, hyperlipidemia and glucose intolerance), metabolic syndrome, stroke, and myocardial infarction/angina pectoris. On the other hand, a negative correlation has been observed between obesity and cancer in certain organs.[3] Thus, it does not necessarily hold true that the lower the BMI the better. This paper attempts to provide an estimate of appropriate BMI from the standpoint of lowering all-cause mortality.

Percentages of Overweight, Obese, and Underweight Adults in Japan

According to the 2000 National Nutrition Survey, the percentages of overweight men and women (BMI≥25.0) aged 20 years or older were 26.8% and 21.3%, respectively (Table 1).[4] According to our calculations, the percentages of obese adults (BMI≥30.0) aged 30 years or older were 2.2% and 3.5% for men and women, respectively, (Table 1).[5] Table 2 shows the percentages of obese persons (BMI≥30.0) (international comparison) provided in a WHO technical report,[1] although it is difficult to compare Japanese data with those of other countries because of differences in figures for sex, age structure, and year of survey. Taking into account the years of survey (and the fact that obesity tends to be increasing in all countries), it can be said that the percentage of obesity is very low in Japan.

On the other hand, the percentages of underweight men and women (BMI<18.5) aged 20

Table 1 Distribution of BMI Categories by Sex and Age Group

	Age of years	Total (No. of subjects)	Underweight (BMI<18.5)	Normal (18.5≤BMI<25.0)	Overweight (BMI≥25.0)	Obese (BMI≥30.0)
Male	Total	100.0% (3,763)	4.8%	68.5%	26.8%	2.2%
	20–29	100.0 (512)	6.3	75.2	18.6	—
	30–39	100.0 (556)	4.1	68.5	27.3	3.1
	40–49	100.0 (627)	2.7	68.4	28.9	2.5
	50–59	100.0 (775)	3.9	66.2	29.9	2.6
	60–69	100.0 (740)	3.2	66.1	30.7	2.4
	≥70	100.0 (553)	9.6	68.7	21.7	0.2
Female	Total	100.0% (4,542)	10.3%	68.5%	21.3%	3.5%
	20–29	100.0 (554)	24.2	69.0	6.9	—
	30–39	100.0 (703)	17.5	69.6	12.9	2.8
	40–49	100.0 (766)	5.5	74.3	20.2	4.0
	50–59	100.0 (962)	5.4	71.0	23.6	3.6
	60–69	100.0 (799)	5.8	63.2	31.0	4.2
	≥70	100.0 (758)	9.2	63.5	27.3	2.9

Note: Pregnant women were excluded. Data on obesity were limited to the persons aged 30 years or older.
(From Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002./*Cardiovascular Disease Prevention Study Group (ed.): *Complete Data from the 5th Basic Survey of Cardiovascular Disease — Numerical Profile of the Status of Cardiovascular Disease*. Chuohoki Publishers, Tokyo, 2003.)

years or older were 4.8% and 10.3%, respectively. In relation to age group, the percentage was particularly high in women between 20 and 29 years of age (24.2%) and 30 and 39 years of age (17.5%) (Table 1).

Table 2 International Comparison of Prevalence (%) of Obese Persons (BMI≥30.0)

Country	Year of survey	Age of years	Male	Female
US	1988–1994	20–74	19.9	24.9
Canada	1986–1990	20–70	15.0	15.0
Brazil	1989	25–64	5.9	13.3
UK	1995	16–64	15.0	16.5
Germany	1992	25–65	20.5	26.8
Netherlands	1995	20–29	8.4	8.3
Sweden	1988–1989	16–84	5.3[*1]	9.1[*1]
Australia	1989	25–64	11.5	13.5
Japan	1993	≥20	1.8	2.6
Japan	2000	≥15	2.3[*2]	3.3[*2]

[*1]Percentage of persons with BMI≥28.6.
(From WHO: *Obesity: Preventing and Managing the Global Epidemic — Report of a WHO Consultation*. WHO, Geneva, 2000./ [*2]-Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

Table 3 presents mean BMI values and standard deviations according to sex and age obtained from the 2000 National Nutrition Survey.[4)]

Annual Changes in the Percentages of Overweight and Underweight Adults in Japan

Figure 1 compares the percentages of overweight adults (BMI≥25.0) in Japan for the years 1980, 1990, and 2000.[4)] Among men, the percentage of overweight adults tended to increase in every age group, although the increase has slowed over the past decade in those in their 20s and 40s. Among women, the percentage of overweight adults tended to decrease in the younger generations, but not among those aged 60 years or older. For women in their 60s, the increasing tendency reversed between 1990 and 2000, and the

Table 3 Mean BMI and Standard Deviation by Sex and Age Group

Age of years	Male			Female		
	No. of subjects	Mean value	Standard deviation	No. of subjects	Mean value	Standard deviation
Total	4,036			4,730		
15–19	273	20.7	3.0	292	20.4	2.6
20–29	512	22.4	3.4	514	20.5	3.2
30–39	556	23.4	3.3	650	21.5	3.5
40–49	627	23.5	3.3	760	22.7	3.5
50–59	775	23.6	3.0	960	23.6	17.3
60–69	740	24.2	13.5	797	23.6	3.5
≥70	553	22.6	3.0	757	23.1	3.5
(Re-sorted)						
≥20	3,763	23.2	3.2	4,542	22.5	3.6
60–64	405	24.9	18.0	447	23.4	3.3
65–69	335	23.3	3.2	350	23.9	3.7
70–74	266	23.1	3.0	336	23.6	3.5
75–79	161	22.5	3.1	227	23.2	3.2
≥80	126	21.5	2.8	194	22.0	3.6

Note: Subjects were 15 years old or older, and pregnant women were excluded.
(From Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

increase in the percentage among women aged 70 years or older during this period was smaller than in the previous decade. These changes may reflect a diet-oriented trend among Japanese women.

When attention was focused on underweight adults (BMI<18.5) (Fig. 2), the percentage of such men tended to decrease, whereas it increased markedly among women in their 20s and 30s. Over the past decade, the percentage of underweight adults also increased slightly among women in their 40s and 50s. Thus, a contrasting picture of obesity and undernutrition — "undernutrition in an age of gluttony" — has emerged among young women in Japan.

Figure 3 shows the percentages of overweight adults in large cities, smaller cities, and towns and villages (N. Yoshiike: personal communication). Among men aged 20–49 years, the percentage of those overweight increased

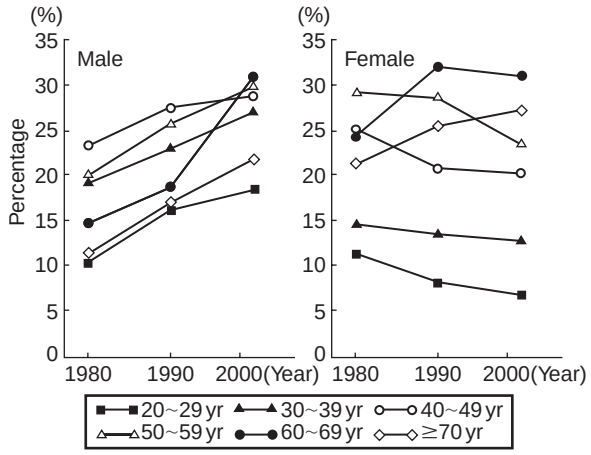

Fig. 1 Annual changes in the percentage of overweight adults (BMI≥25.0)
(From Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

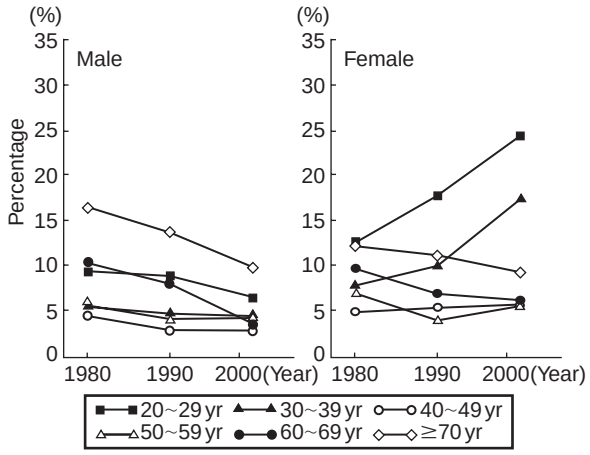

Fig. 2 Annual changes in the percentage of underweight adults (BMI<18.5)
(From Health and Nutritional Information Study Group (ed): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

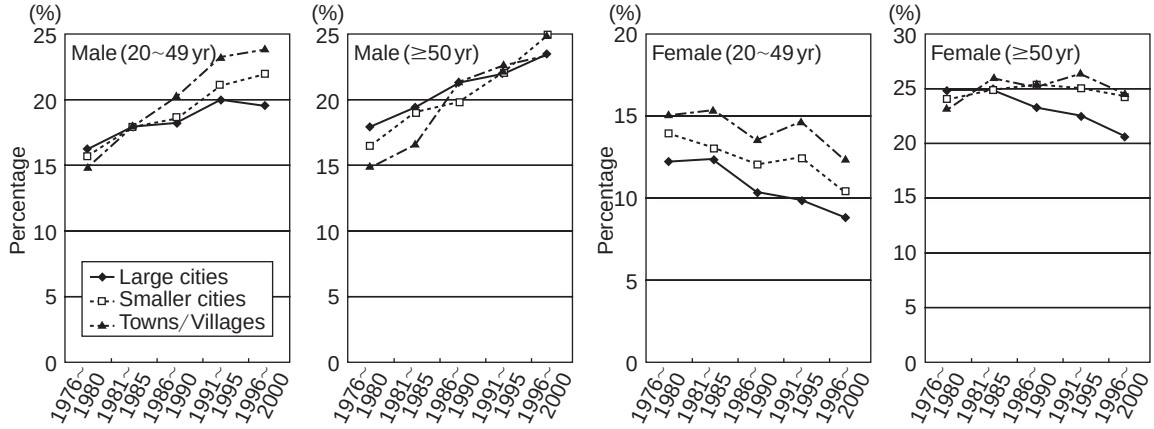

Fig. 3 Annual changes in the percentage of overweight adults (BMI≥25.0)
(Data calculated by N. Yoshiike, from the results of the 1976–2000 National Nutrition Surveys conducted by the Ministry of Health, Labor and Welfare)

markedly in towns and villages. The reason for this increase is presumed to be an increased use of cars (for commuting, etc.) and insufficient physical activity, in addition to decreased work intensity and shortened working hours in primary industries such as farming. Among women, the percentage of those overweight generally tended to decrease. The percentage was particularly low in women aged 20–49 years living in large cities. Among women aged 50 years or older, the percentage of those overweight also decreased in large cities. It has become apparent that the issue of increasing obesity is specific to men living in towns and villages, while that of underweight individuals is specific to women living in large cities. Measures to control obesity at the population level in this country should take into account sex, age (generation), and living environment. Undernutrition in young women may become an important issue in maternal and child health.

Large-Scale Cohort Studies on BMI and All-Cause Mortality

A very large sample size is necessary when people are classified according to BMI into a large number of categories and the all-cause mortality for each category is determined. The study design most suitable for determining

Table 4 BMI and All-Cause Mortality (US Caucasian Adults, 1982–1996)

	BMI	<18.5	18.5–20.4	20.5–21.9	22.0–23.4	23.5–24.9	25.0–26.4
Male	No. of deaths	93	305	734	1,523	2,085	2,250
	Person-year	5,438	19,847	61,863	148,107	216,788	239,158
	Age-adjusted mortality	1,270	1,133	1,022	953	956	1,007
	Multivariate-adjusted relative risk*	1.26	1.19	1.09	1.01	1.00	1.04
	95% confidence interval	1.02–1.56	1.05–1.34	1.00–1.18	0.95–1.07	—	0.98–1.10
Female	No. of deaths	680	2,054	3,003	3,344	3,133	2,522
	Person-year	55,362	314,575	495,542	507,570	422,903	302,692
	Age-adjusted mortality	923	732	671	653	673	727
	Multivariate-adjusted relative risk*	1.36	1.10	1.00	0.97	1.00	1.07
	95% confidence interval	1.25–1.48	1.04–1.16	0.95–1.05	0.93–1.02	—	1.01–1.13
	BMI	26.5–27.9	28.0–29.9	30.0–31.9	32.0–34.9	35.0–39.9	≥40.0
Male	No. of deaths	1,738	1,338	592	398	153	19
	Person-year	181,735	125,967	56,682	32,878	11,079	1,315
	Age-adjusted mortality	1,058	1,255	1,300	1,619	2,076	2,065
	Multivariate-adjusted relative risk*	1.09	1.28	1.32	1.66	2.17	2.58
	95% confidence interval	1.02–1.16	1.19–1.37	1.21–1.45	1.49–1.85	1.84–2.56	1.64–4.06
Female	No. of deaths	2,173	1,913	1,225	953	462	144
	Person-year	261,253	215,245	130,432	95,505	48,414	14,372
	Age-adjusted mortality	755	837	908	1,083	1,216	1,399
	Multivariate-adjusted relative risk*	1.10	1.21	1.30	1.53	1.76	2.00
	95% confidence interval	1.04–1.17	1.14–1.28	1.22–1.39	1.42–1.65	1.60–1.94	1.69–2.36

The subjects were never-smokers who had no history of cancer, heart disease, stroke, chronic bronchitis, pulmonary emphysema, bronchial asthma, or weight loss of over 10 lb (4.53 kg) in the previous year.
Age-adjusted mortality is expressed in deaths per 100,000 person-years.
*Multivariate-adjusted relative risk: Using Cox proportional hazard model. Adjusted variates: Age, education level, physical activity, alcohol consumption, marital status, aspirin therapy, fat intake, vegetable intake, and estrogen replacement therapy (women).

(From Calle, E.E. *et al.*: *N Engl J Med* 1999; 341:1097–1105.)

the optimal value of BMI for longevity, using total mortality as an index, is the cohort study. In addition, those with diseases, such as cancer, that may lead to undernutrition or underweight at baseline should be excluded from the cohort. Since it is impossible to perform a thorough examination of every subject in the cohort to determine the presence/absence of disease, it is necessary to exclude from analysis subjects who die in an early phase of the follow-up period. Only a few studies fulfill these requirements.

Calle *et al.*[6] studied a cohort of 457,785 male and 588,369 female volunteers from all areas of the US who had never smoked and had no history of disease. The follow-up period was between 1982 and December 1996. Table 4 shows the results for Caucasian men and women. Among Caucasian men, the relative risk (RR; after being adjusted for confounding variables) of total mortality was lowest when BMI was 23.5–24.9. The relative risk at a BMI of 22.0–23.4 or 25.0–26.4 was slightly higher, but not statistically significantly different, than that at a BMI of 23.5–24.9. The dose-response relationship showed a J-shaped curve, with an RR of 1.26 at BMI<18.5 (lowest BMI category) and an RR of 2.58 at BMI≥40.0 (highest BMI category). Among Caucasian women, RR was lowest when BMI was 22.0–23.4. However, there was no statistically significant difference from the reference (RR = 1.00) at BMI of 23.5–24.9. The dose-response curve was J-shaped, showing an RR of 1.36 at BMI<18.5 and RR of 2.00 at BMI≥40.0.

Tsugane *et al.*[7] reported the results of a 10-year follow-up of the cohort of the JPHC Study (Japan Public Health Center-Based Prospective Study on Cancer and Cardiovascular Diseases) supported by the Ministry of Health,

Table 5 BMI and All-Cause Mortality (Japanese Adults, 1990–1999)

	BMI	14.0–18.9	19.0–20.9	21.0–22.9	23.0–24.9	25.0–26.9	27.0–29.9	30.0–39.9
Male	All deaths during follow-up							
	No. of deaths	67	184	268	202	121	74	27
	Person-year	6,324	27,132	48,984	53,740	32,856	16,320	3,854
	Multivariate-adjusted relative risk*	2.26	1.57	1.33	1.00	1.14	1.38	1.97
	95% confidence interval	1.66–3.08	1.25–1.98	1.09–1.63	—	0.90–1.45	1.03–1.83	1.27–3.06
	Excluding deaths occurring in the first 5 years of follow-up							
	No. of deaths	41	116	158	129	81	40	14
	Multivariate-adjusted relative risk*	2.35	1.66	1.30	1.00	1.19	1.19	1.51
	95% confidence interval	1.58–3.49	1.24–2.22	1.01–1.69	—	0.90–1.61	0.81–1.73	0.81–2.82
Female	All deaths during follow-up							
	No. of deaths	42	66	111	99	82	58	25
	Person-year	10,005	31,399	54,863	52,436	33,238	20,866	6,619
	Multivariate-adjusted relative risk*	1.94	0.98	0.99	1.00	1.30	1.33	1.91
	95% confidence interval	1.30–2.89	0.69–1.40	0.74–1.32	—	0.96–1.76	0.94–1.88	1.22–2.99
	Excluding deaths occurring in the first 5 years of follow-up							
	No. of deaths	23	44	64	68	51	28	16
	Multivariate-adjusted relative risk*	1.46	0.91	0.82	1.00	1.13	0.90	1.72
	95% confidence interval	0.87–2.46	0.59–1.39	0.57–1.17	—	0.78–1.64	0.57–1.44	0.99–2.98

*Multivariate-adjusted relative risk: Using Cox proportional hazard model. Adjusted variates: Region of survey, age, smoking status, alcohol consumption, education level, sports/recreational physical activity, and weight gain or loss of over 5 kg after 20 years of age.

(From Tsugane, S. *et al.*: *Int J Obes Relat Metab Disord* 2002; 26: 529–537)

Labor and Welfare (Table 5). A total of 27,063 men and 27,435 women aged 40–59 years living in Iwate, Akita, Nagano, Ishikawa, and Okinawa Prefectures were surveyed at baseline in January 1990 and followed until December 1999. In men, the relative risk of all-cause mortality was lowest (RR = 1.00) when BMI was 23.0–24.9. The dose-response curve was U-shaped, showing an RR of 2.26 at a BMI of 14.0–18.9 (lowest BMI category) and an RR of 1.97 at a BMI of 30.0–39.9 (highest BMI category). This U-shaped association did not change after excluding deaths occurring in the first 5 years of follow-up. In women, the relative risk was lowest (RR = 0.98) when BMI was 19.0–20.9. There was also a U-shaped dose-response relationship, with an RR of 1.94 at a BMI of 14.0–18.9 and an RR of 1.91 at a BMI of 30.0–39.9. Again, the U-shaped association was hardly changed after excluding deaths that occurred during the first 5 years of follow-up. However, the lowest relative risk (RR = 0.82) was obtained when BMI was 21.0–22.9.

Thus, there is clear evidence from the above-mentioned studies and a number of other studies that there is a J-shaped or U-shaped dose-response relationship between BMI and all-cause mortality. It has been noted that pneumonia and stroke (particularly intracerebral hemorrhage) are responsible for the increased all-cause mortality among underweight persons.[8,9] This was also demonstrated in epidemiologic studies of stroke carried out in Japan during its era of high-speed economic growth.[10–12]

Conclusion

The percentages of obese men and women (BMI≥30.0) in Japan who are 30 years old or older are 2.2% and 3.5%, respectively (Table 1). These figures are much lower than those found in Western countries. The percentage of overweight men (BMI≥25.0) is tending to increase, particularly in rural rather than urban areas. Although obesity is not a current public health issue in Japan, it is possible that it may surface as a future problem. Therefore, greater importance should be attached to counteracting obesity through preventive measures rather than through the treatment of obesity itself. The target should be men in particular. The percentage of obesity is decreasing among young women, a feature that seems peculiar to Japan. Thus, there is a double structure of obesity and a new type of "undernutrition." For Japanese women, the need to control underweight is greater than that for obesity control.

The dose-response relationship between BMI and all-cause mortality is generally J- or U-shaped, suggesting that not only obesity but also underweight is an important issue in preventive medicine. Lower all-cause mortality seems to be associated with a BMI of 23.0–24.9 in adult men and 21.0–22.9 in adult women in Japan. Being "slightly plump" is favorable for men in terms of mortality in both Japan and the US. Although WHO has prescribed a normal range of BMI of 18.50–24.99,[1] the BMI figures for Japanese people correspond to the upper one-third of this range.

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Women and Obesity

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Abstract: Problems related to obesity in women include 1) menstrual disorders and decreased fertility associated with obesity in the adolescent and reproductive periods, 2) increased perinatal abnormalities in obese pregnant women, and 3) increased incidence of cardiovascular diseases, cancer of the corpus uteri, and breast cancer in obese postmenopausal women. Menstrual disorders and low fertility occur frequently in both obese and underweight women. The incidence of menstrual abnormalities is lowest when the body mass index (BMI) is 22–23. Recently, attention has been given to an increase in underweight rather than obese pregnant women and the associated decrease in the birth weight of infants. However, obesity in pregnant women is associated with a higher incidence of complications of pregnancy (e.g., preeclampsia and gestational diabetes) and abnormal labor. Obesity, particularly that characterized by the accumulation of visceral fat, increases in women after 40 years of age, and its incidence in women in their 50s reaches a level similar to that in men. With this increase, hyperlipidemia and cardiovascular diseases increase markedly in postmenopausal women. In addition, cancer of the corpus uteri and breast cancer are closely related to obesity after menopause.

Key words: Menstrual disorders; Insulin resistance; Cardiovascular disease; Perinatal abnormalities

Introduction

Problems related to obesity in women include menstrual disorders and decreased fertility associated with obesity in the adolescent and reproductive periods, increased perinatal abnormalities in obese women during pregnancy and after pregnancy or delivery, and increased incidence of cardiovascular diseases, hyperlipidemia, cancer of the corpus uteri, and breast cancer in obese postmenopausal women.

Obesity and Menstrual Disorders in the Adolescent and Reproductive Periods

A J-shaped curve is characteristic of the

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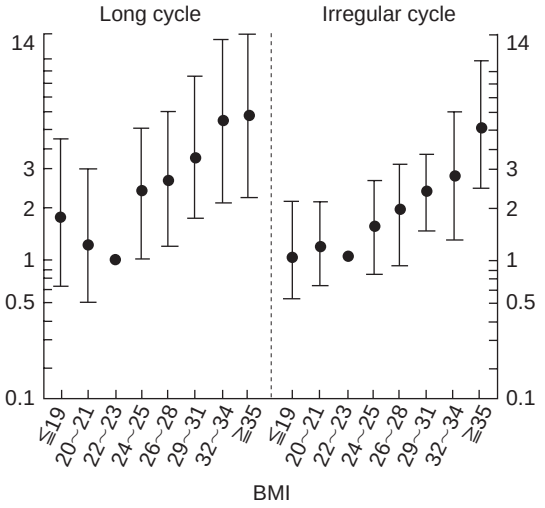

Fig. 1 Relationship between menstrual disorders and BMI
Risks for menstruation with long menstrual cycles (left) and irregular cycles (right) show J-shaped correlations with BMI. These risks are lowest at a BMI of 22–23. Long or irregular menstrual cycles are often accompanied with ovarian dysfunction and decreased fertility.
(From Rowland AS, *et al.*: *Epidemiology* 2002; 13: 668–674)

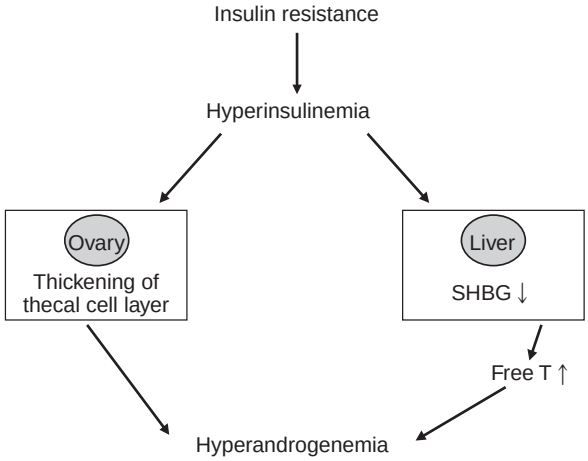

Fig. 2 Relationship between insulin resistance and hyperandrogenemia in obese women, particularly with visceral fat-type obesity, and patients with PCOS
Insulin resistance induces hyperandrogenemia through two mechanisms, promotion of androgen production in the ovaries and inhibition of SHBG production in the liver.
T: testosterone SHBG: sex hormone-binding globulin

association between body weight and reproductive function in women. Both overweight and underweight in women are associated with increased frequencies of abnormalities in reproductive function, e.g., menstrual disorders, infertility, and abnormalities in pregnancy or labor.

1. Obesity and menstrual disorders

Both obesity and underweight are associated with a high incidence of menstrual disorders. The menstrual cycle is usually 28–30 days. Women who have a long or irregular cycle often exhibit ovulation disorders or decreased fertility. When the body mass index (BMI) is 22–23, the incidence of menstrual disorders is the lowest. The risk of menstrual disorders is double in women with a BMI of 24–25 and fivefold higher in those with a BMI of 35 or more (Fig. 1).[1)] In contrast, obesity is common among women with menstrual disorders. According to a study,[2)] the frequency of obesity was 9–13% among women with a normal menstrual cycle, whereas it reached 45% among those with menstrual disorders.

2. Type of obesity and menstrual disorders

The type of obesity is a salient feature in menstrual disorders. These disorders are more frequent among women with visceral fat-type obesity (upper body type or male type) than those with subcutaneous-type obesity (lower body type or female type).[3)] As the waist-to-hip ratio increases, the incidence of menstrual disorders increases, as does infertility. A study that measured fat mass in various parts of the body by dual-energy X-ray absorptiometry and compared women with menstrual disorders and those with regular menstruation who had similar BMI revealed that trunk fat mass was significantly higher in women with menstrual disorders.[3)]

3. Obesity and endocrine abnormalities

As mechanisms of the effects of obesity on ovarian function, attention currently is focused on 1) disturbed estrogen metabolism, 2) decreased sex hormone-binding globulin (SHBG), 3) insulin resistance and hyperinsulinemia, and

4) leptin abnormality.

A characteristic feature of the blood hormone profile in obese women is high levels of androgen and luteinizing hormone (LH). Obese individuals, particularly with visceral fat-type obesity, may have insulin resistance and hyperinsulinemia. This leads to thickening of the theca cell layer in the ovaries, and results in increased production of androgen there. In addition, hyperinsulinemia induces a decrease in SHBG in the liver, and decreased SHBG may further increase active androgen, influencing ovulation and menstrual cycle (Fig. 2).[1)]

The observation that leptin-deficient obese mice (*ob/ob* mice) were infertile, but regained fertility following leptin supplementation, has focused attention on leptin as a possible cause of menstrual disorders and infertility in obese women. However, much remains to be clarified as to the role of leptin in human reproduction.[4)]

4. Does weight loss improve menstrual disorders?

It has been reported that weight loss normalizes the hormonal environment in obese women, helping restore normal menstrual cycles and fertility. Weight loss improves elevated blood levels of androgen and LH, resulting in improvement of menstrual cycles and fertility.[5)] Even if weight loss does not reach the ideal weight, it reportedly achieves normal hormone levels, improves ovulation and menstrual cycle, and enhances fertility.

5. Polycystic ovary syndrome

Polycystic ovary syndrome (PCOS) is an important disease that requires careful differentiation from menstrual disorders caused by simple obesity. PCOS, a condition commonly characterized by obesity and menstrual disorders, was first described by Stein and Leventhal in 1935 as characterized by amenorrhea, infertility, hirsutism, obesity, and ovarian enlargement. It has been pointed out that elevated blood levels of LH and androgen are noted in patients with PCOS. The recent finding that hyperinsulinemia and acanthosis nigricans are noted in patients with PCOS who have the hirsutism has focused attention on insulin resistance as a possible cause. Since hyperinsulinemia causes thickening of the thecal cell layer, resulting in increased androgen production, this condition is recognized as an important causative factor of PCOS.[6)] Table 1 shows the diagnostic criteria proposed by the Japan Society of Obstetrics and Gynecology.

Table 1 Proposed Diagnostic Criteria for PCOS
(Reproduction and Endocrine Committee of the Japan Society of Obstetrics and Gynecology, 1993)

I.	Clinical symptoms
	① **Menstrual disorders (amenorrhea, oligomenorrhea, anovulatory cycle, etc.)**
	2. Virilization (hirsutism, acne, low voice, clitoral hypertrophy)
	3. Obesity
	4. Infertility
II.	Endocrine features
	① Increased basal secretion of LH, and normal-range FSH
	2. Hyperresponse of LH and virtually normal response of FSH to LHRH-loading test
	3. Elevated estrone/estradiol ratio
	4. Elevated blood levels of testosterone or androstenedione
III.	Ovarian findings
	① Multiple follicles on ultrasonography
	2. Ovarian enlargement on pelvic examination on ultrasonography
	3. Thickening of tunica albuginea of the ovary on laparotomy or laparoscopy
	4. Hypertrophy and hyperplasia of the internal thecal cell layer and interstitial cell proliferation on histological examination

Note: Items with circled number are necessary items. Cases in which all necessary items are present are diagnosed as having polycystic ovary syndrome. Other items are reference items. Cases in which all reference items and necessary items are present are regarded as typical cases.

LH: luteinizing hormone FSH: follicle-stimulating hormone
LHRH: luteinizing hormone-releasing hormone

Obesity during Pregnancy and Increase in Pregnancy Complications

Two major problems in pregnancy are associ-

Table 2 Body Type during Non-Pregnancy and Incidence of Perinatal Abnormality (%)

Perinatal abnormality	Underweight ($n=107$)	Normal ($n=648$)	Obese ($n=53$)
SGA	8.4 *1,*2	3.9 *1	0 *2
LGA	0 *3	2.9 *4	9.4 *3,*4
Gestational toxicosis	4.7 *5	8	18.9 *5
Caesarean section	4.7 *6	6.6 *7	15.1 *6,*7
Neonatal asphyxia	1.9	0.8	3.8

*1, *2, *4~*7: $p<0.05$, *3: $p<0.01$.

SGA: small for gestational age LGA: large for gestational age
(From Watanabe, N. *et al.*: *Sanfujinka Chiryo* 2000; 80: 273–276)

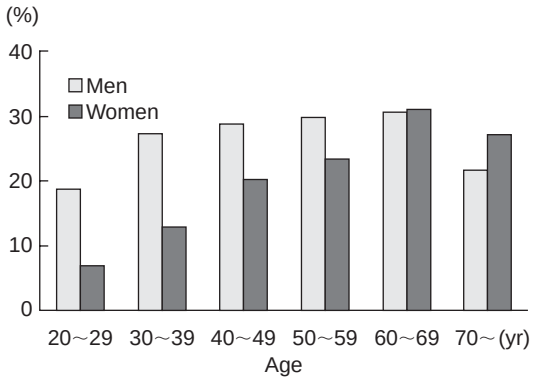

Fig. 3 Percentage of obese men and women (BMI≧25) by age group

Obese individuals account for a certain proportion among men, from young to old, whereas the percentage of obesity in women begins to increase rapidly at age 40–50.

(Outline of the results of the 2000 National Nutrition Survey, based on statistics from Nutrition Survey Section, Office for Life-Style Related Diseases Control, General Affairs Division, Health Service Bureau, Ministry of Health, Labor and Welfare)

ated with obesity: obesity of the mother after pregnancy and delivery, and frequent perinatal complications in obese pregnant women. The degree of obesity increases in some women as the number of para and gravida increases.[7] Pregnant women who have gained a great deal of weight by the 20th gestational week are especially likely to have excessive weight gain during pregnancy and become obese after delivery.

The Committee on Nutritional Issues of the Japan Society of Obstetrics and Gynecology defines obesity as a BMI of 24 or more for non-pregnant women, 26 or more for pregnant women in the second trimester, and 28 or more for those at 10 months of pregnancy. It has been reported that the number of underweight pregnant women has increased recently, leading to a decline in the birth weight of infants. However, underweight pregnant women have infrequent perinatal abnormalities apart from low-birth-weight infants. On the other hand, it has been noted that obese pregnant women are associated with a higher incidence of pregnancy complications and abnormal labor. The incidence of preeclampsia and diabetes as complications of pregnancy increases as the degree of obesity increases. It is also known that the rates of caesarean section and vacuum extraction increase with increasing obesity. In general, the risk of infant death in advanced countries is lower in underweight pregnant women (Table 2).[8] Weight loss in obese women before they become pregnant seems to provide a better prognosis for neonates.[8]

Postmenopausal Obesity and Increase in Cardiovascular Disease, Cancer of Corpus Uteri, and Breast Cancer

1. Does obesity occur after menopause?

Like hyperlipidemia, obesity occurs more frequently in men than in women until 50 years of age. However, the percentage of obese women increases rapidly after 40 years and reaches a level similar to that found in males in the 50s, suggesting that obesity in women increases especially after menopause (Fig. 3). A weight gain of about 0.5 kg/year is usually noted during menopause (about 2.5 kg throughout menopause). This is reported to be due to aging and not related to menopause itself.[9] Thus, overall weight gain itself is unlikely to be related to estrogen deficiency caused by menopause.

There is a general consensus that obesity characterized by visceral fat accumulation is

common in postmenopausal women.[10] It has been shown by several studies using the waist/hip (W/H) ratio as an index that the W/H ratio increases after menopause. In other words, menopause may cause visceral fat-type obesity. In addition, a study using DEXA and CT to determine the extent of intraabdominal visceral fat accumulation has confirmed that menopause is a risk factor for visceral fat-type obesity.[10] Visceral fat-type obesity is an important risk factor for hyperlipidemia, hypertension, and diabetes mellitus, and is also related to a rapid increase in cardiovascular disease in women following menopause.[10]

Various mechanisms have been suggested as the cause of the phenomenon in which estrogen inhibits obesity or estrogen deficiency elicits obesity. Inhibited dietary intake and increased levels of physical activity are considered important roles of estrogen. At the same time, it has been suggested that estrogen directly influences the fat metabolism in the adipose tissue.

2. Postmenopausal obesity and cancer development

Among the various types of cancer, cancer of the corpus uteri is most closely related to obesity. The risk of developing cancer of the corpus uteri increases threefold with 10 kg or more of excess weight and more than 10-fold with 25 kg or more of excess weight. In addition, it has been reported that the increase in risk is greater in cases of visceral fat-type obesity than in subcutaneous-type obesity.[11] Aromatase is present in adipose tissue, and thus the main site of estrogen production after menopause is the adipose tissue. Therefore, obese women have high levels of endogenous estrogen (particularly estrone), and this is considered to be an important mechanism for increased risk of cancer. Obesity also is known to be a risk factor for breast cancer occurring after menopause.[12]

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Role of Body Weight Reduction in Obesity-Associated Co-Morbidities

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Abstract: Obesity is associated with various health problems such as impaired glucose tolerance, hypertension, and hyperlipidemia. The Japan Society for the Study of Obesity (JASSO) has issued new guidelines for the evaluation of obesity and diagnostic criteria of obesity as a disease in the Japanese population and cited 10 obesity-related health problems that require weight loss or are improved by weight loss. Among these health problems, atherosclerotic diseases including ischemic heart disease and cerebrovascular disorder are of particular importance. The Third Report of the US National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (NCEP-ATP III) emphasizes the high risk of people who have a constellation of risk factors for atherosclerosis, categorized as the metabolic syndrome. The pathologic features of metabolic syndrome include insulin resistance, which is related to visceral fat accumulation. Metabolic disorders associated with visceral fat accumulation are closely related to the amount of accumulated visceral fat, and reduction of visceral fat causes improvement in such complications. In designing treatment targeted at adipose cells, it is useful to consider the goals and benefits of obesity therapy by evaluating variations in visceral fat.

Key words: Complications; Visceral fat; Insulin resistance; Metabolic syndrome

Introduction

The pathologic condition of obesity consists of various factors, including genetics, metabolic disorders, lifestyle, and personality. Therefore, comprehensive action based on a clear understanding of the relative contributions of individual factors is necessary in the treatment of obesity.

In 2000, the Japan Society for the Study of Obesity (JASSO) issued new guidelines for the evaluation of obesity and diagnostic criteria of obesity as a disease in the Japanese population, to provide clear guidance for evaluating and

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diagnosing obesity in daily clinical practice. Recent years have seen progress in elucidating the mechanisms by which obesity and its accompanying metabolic disorders develop, and hence the target of therapy for obesity as a disease has become more obvious. It became apparent that the accumulation of visceral fat around the abdominal organs is associated with a number of metabolic disorders, and that such visceral fat-type obesity is closely related to insulin resistance, an important factor in the development and progression of metabolic syndrome. As this pathologic condition continued to be better defined, investigation of the responsible adipose cells increased, with attention focused on their morphologic role as lipid-accumulating cells and their function in inducing metabolic disorders accompanying obesity, and the importance of weight loss therapy, particularly of the accumulated visceral fat, was demonstrated.

Table 1 Clinical Identification of Metabolic Syndrome

Risk Factor	Defining Level
Abdominal Obesity (Waist Circumference)	
Men	>102 cm (>40 in)
Women	>88 cm (>35 in)
Triglycerides	≧150 mg/dl
HDL-cholesterol	
Men	<40 mg/dl
Women	<50 mg/dl
Blood pressure	≧130/≧85 mmHg
Fasting glucose	≧110 mg/dl

Metabolic syndrome is identified by the presence of three or more of the risk factors.

[Adapted from Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA* 2001; 285: 2486–2497]

Obesity-Associated Co-Morbidities

Obesity is associated with various health problems including impaired glucose tolerance, hypertension, and hyperlipidemia. JASSO's new guidelines for the evaluation of obesity and diagnostic criteria of obesity cites 10 health problems associated with obesity.[1)] Although many other conditions in addition to these 10 problems are related to obesity, those that are unlikely to be much improved by weight loss are mentioned separately only for reference.

Much recent attention has focused on the importance of obesity in cases of liver diseases such as non-alcoholic steatohepatitis (NASH), insulin resistance, and metabolic syndrome.[2)] Among these health problems associated with obesity, atherosclerotic diseases including ischemic heart disease and cerebrovascular disorders are of particular importance. Although obesity is an independent risk factor for coronary artery disease, its direct contribution is slight (about 1.3-fold), and it becomes less independent with aging. Namely, when an increase in whole body fat in terms of degree of obesity is present, the degree of contribution of obesity to atherosclerotic disease is low, and the concomitant presence of other risk factors, rather than obesity itself, is more important. In fact, obese people are about 5-fold and about 3.5-fold more likely to develop diabetes and hypertension, respectively, than those of normal weight. For atherosclerosis, obesity itself is an independent risk factor. However, it is of greater importance that obesity is likely to be accompanied with other risk factors, particularly a constellation of risk factors.

The concept of metabolic syndrome as a new disease has been proposed in recent years. Together with this concept, the importance of visceral fat accumulation, rather than the absolute amount of obesity as expressed by degree of obesity, has been stressed.

Metabolic Syndrome

The US National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) emphasizes that a constellation of athero-

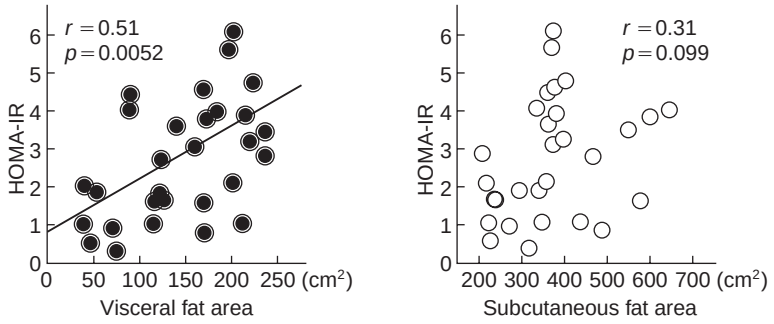

Fig. 1 Correlation between HOMA-IR and accumulation of visceral and subcutaneous fat

sclerotic risk factors should be diagnosed as metabolic syndrome and be treated to reduce the risk of coronary artery disease, considering it the secondary target of therapy following the primary target of low-density lipoprotein cholesterol (Table 1).[3] This disease concept is pathologically similar to previously described conditions: multiple-risk-factor syndrome, visceral-fat syndrome, the deadly quartet, syndrome X, and insulin-resistance syndrome.

The mechanism by which the visceral fat accumulation involved in the pathology of these syndromes is closely related to the obesity-associated co-morbidities is suggested by the difference in function between visceral fat and subcutaneous fat. In recent years, it has become apparent that the genes of various adipocytokines, such as plasminogen activator inhibitor-1 (PAI-1), tumor necrosis factor-α (TNF-α), and adiponectin, are expressed in adipose tissue, leading to the view that adipose tissue is a kind of endocrine organ. In particular, it has been reported that the expression of PAI-1 increases with the accumulation of visceral fat, whereas there is no change in PAI-1 expression in subcutaneous fat.[4]

Impaired glucose tolerance in cases of visceral fat accumulation resulting from these pathologic conditions is characterized by insulin resistance and compensatory hyperinsulinemia.[5] Even if the fasting blood glucose level is normal in the glucose tolerance test, obese people often show impaired glucose tolerance or diabetic response after loading, with insulin levels being high both during fasting and after loading. An index of insulin resistance, the homeostasis model assessment of insulin resistance (HOMA-IR), shows a significant positive correlation with visceral fat area (Fig. 1).

The characteristic features of lipid metabolism disorder include increased serum triglyceride (TG) and decreased high-density lipoprotein (HDL) cholesterol. The mechanisms involved in this metabolic disorder are increased synthesis of very low-density lipoprotein (VLDL) in the liver and disturbed catabolism of the TG-rich lipoprotein associated with insulin resistance. In addition, the incidence of hypertension has a positive correlation with body mass index (BMI). In particular, visceral fat accumulation is involved in the concomitant development of hypertension. In people with visceral fat-type obesity, blood pressure values are higher than in those with subcutaneous-type obesity, and reduction in visceral fat by weight loss contributes to improvement in blood pressure. Thus, insulin resistance plays an important role in metabolic syndrome, which is characterized by various pathologic conditions derived from obesity.

Obesity-Associated Co-Morbidities and Body Weight Reduction

The therapeutic goal in treating obesity is to improve health problems resulting from exces-

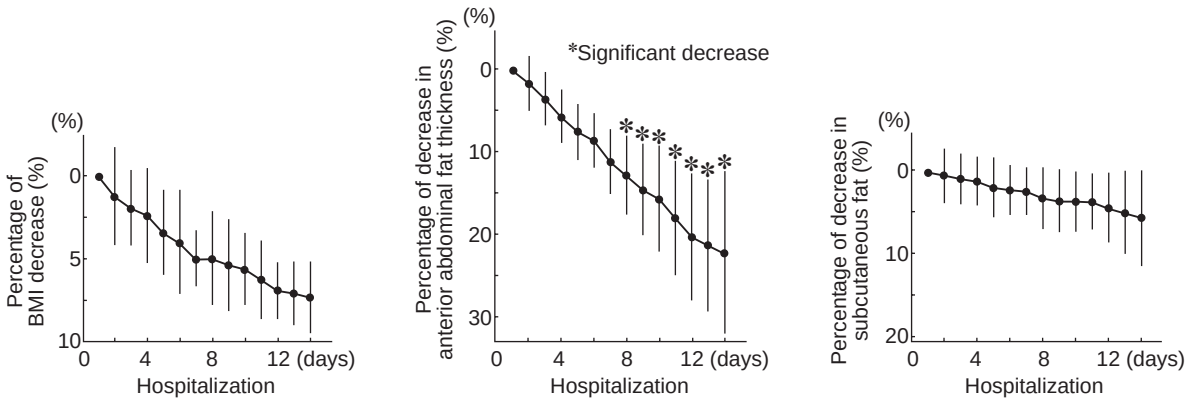

Fig. 2 Changes in fat distribution in the early phase of weight loss
Body fat distribution was determined in 10 patients undergoing hospitalization for obesity.
(Adapted from Li, Y. *et al.*: Visceral fat: higher responsiveness of fat mass and gene expression to calorie restriction than subcutaneous fat. *Exp Biol Med* 2003 Nov; 228(10): 1118–1123.)

sive fat accumulation. Therefore, in treating the obesity-associated co-morbidities, it is important to determine the relationship between variations in visceral fat accumulation and improvement in complications during the course of treatment. A diagnosis of visceral fat accumulation is established by CT scan performed at the umbilical level. Ultrasonography, which causes minimal stress to the patient, is useful for determining variations in visceral fat and subcutaneous fat during treatment.[6] By this technique, the degree of visceral fat accumulation can be expressed as anterior abdominal fat thickness, and subcutaneous fat accumulation as subcutaneous fat thickness. When fat thickness is measured every day during the hospitalization of obese patients, anterior abdominal fat thickness is found to decrease markedly in the early stage of therapeutic weight loss, whereas the concurrent decrease in subcutaneous fat thickness is minimal (Fig. 2).[7] As anterior abdominal fat thickness decreases, hypertriglyceridemia improves. Blood insulin, PAI-1 and TNF-α levels also decrease, suggesting that reduction in anterior abdominal fat thickness causes improvement in insulin resistance.

Thus, metabolic disorders associated with visceral fat accumulation are closely related to the amount of accumulated visceral fat, and the obesity-associated co-morbidities can be ameliorated by reducing the accumulation of visceral fat. From this point of view, it is useful when designing treatment targeted at adipose cells to consider the goals and benefits of obesity therapy by the simple evaluation of variations in visceral fat.

Conclusion

Obesity-associated co-morbidities, particularly pathologic conditions related to insulin resistance, have been outlined, and the effects of weight loss on such conditions have been described. A variety of approaches have been used to study the obesity-associated co-morbidities and the effects of weight loss on these complications. The results of such investigations may lead to rapid progress in the treatment of obesity. It is expected that the treatment system used to accurately assess and selectively decrease multifunctional adipose cells, particularly those of visceral fat, will be established on the basis of JASSO's new guidelines for the evaluation of obesity and diagnostic criteria of obesity as a disease in the Japanese population.

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