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Low Back Pain in Young and Middle-Aged People

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Toshihiko TAGUCHI

Associate Professor, Department of Orthopedic Surgery,
Yamaguchi University School of Medicine

Abstract: The low back pain in the young and middle-aged people is characterized by "so-called low back pain," or nonspecific low back pain in which the cause is difficult to identify, that is more common compared with other age groups. Behind the high incidence of nonspecific low back pain of young and middle-aged people lies the fact that these people must maintain a high degree of activity of daily life at the time when the aging-related changes in the lumbar spine and tissues surrounding the lumbar spine start to occur, thus creating a gap between social needs and physical capabilities. Nonspecific low back pain must often be diagnosed based on exclusion, and it is important in particular to differentiate serious diseases such as spinal tumor and infectious spine diseases. Symptomatic therapies and instructions on daily life are performed mainly as the treatment methods, thereby it is important to eliminate patients' anxiety by explaining that the condition is not a disease of malignant nature and that no concern is needed in this regard. In the case of acute pain, it is also important in the treatment to prevent the condition from becoming chronic. The onset of nonspecific low back pain involves various factors, and socio-psychological factors may also be involved as an important cause, besides structural and physiological abnormalities in the lumbar region. In responding to the complaint of low pack pain, tackling this disease by grasping the whole picture of each patient's life from the standpoint of a living function-related disease, instead of merely providing anti-inflammatory analgesics, is considered to lead to early social rehabilitation.

Key words: Low back pain; Young and middle age; Pathology; Treatment

Introduction

The frequency of low back pain increases as age advances, and its prevalence in the elderly population of age 40 and older is as high as 20 to 40%. On the other hand, the prevalence of

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low back pain is about 10 to 25% in the age group from the late teens to age 40, defined here as young and middle-aged people, and in this age group the incidence of low back pain itself is relatively low. People in this age group are highly active in daily life and are exposed to various stresses. Unlike in the elderly, however, the aging-related changes are minimal in this age group. Due to these circumstances, therefore, low back pain in this age group is characterized by high incidence of "so-called low back pain", or nonspecific low back pain without any clear-cut diagnosis being specified.

In this report, I will discuss nonspecific low back pain, which is clinically the most common low back pain in young and middle-aged people.

Characteristics of Low Back Pain in Young and Middle-Aged People —Nonspecific Low Back Pain

The causes of low back pain are diverse, as with headache and stomachache, and diseases with low back pain as the chief complaint involve various specialized fields. Among them, low back pain from the lumbar spine can be classified into the following three categories: (1) nonspecific low back pain, (2) radicular pain, and (3) pain due to serious spinal lesions. Serious spinal lesions include tumor, infection, and cauda equina syndrome.

The background of low back pain in young and middle-aged people is the gap between social needs and physical capabilities, caused by the need to maintain high degree of activity of daily life (ADL) at the time when age-related changes of the lumbar spine and the tissues surrounding the lumbar spine start. Low back pain whose cause is difficult to identify because of its onset with such a background is called nonspecific low back pain, and in young and middle-aged people it is characterized by more frequent nonspecific low back pain, compared with other age groups.

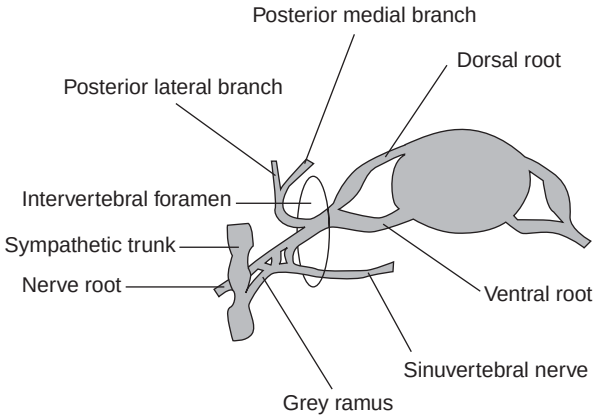


Fig. 1 Nerves related to low back pain

Pathology of Non-Specific Low Back Pain

There are not so many nerves related to low back pain as might be imagined, and they can be largely classified into dorsal and ventral rami of spinal nerves. Ventral rami of spinal nerves consist of spinal nerve roots, recurrent branches called sinuvertebral nerves, and grey rami that communicate with sympathetic nerves. Dorsal rami of spinal nerves consist of medial branches, distributed medially to the spine, and lateral branches distributed outside. Because nonspecific low back pain does not involve nerve root symptoms or cauda equina symptoms, nerves other than spinal nerve roots, which are sinuvertebral nerve, grey rami, medial branches, and lateral branches, are considered to be related to nonspecific low back pain (Fig. 1).

As to the areas innervated by these nerves,[1] sinuvertebral nerves innervate epidural connective tissue, dura matter, posterior longitudinal ligaments, and discs, and grey rami innervate anterior longitudinal ligaments and uncovertebral joints. Among dorsal rami, medial branches innervate facet joints, multifidus muscle, and rotator muscle, and lateral branches innervate thoracolumbar fascia, intertransverse muscles, lumbar quadrate muscles, erectors, and skin of the low back region. Therefore, every region innervated by these nerves can

cause nonspecific low back pain, and it is difficult to systematically classify them. Also, clinical characteristics of low back pain from these regions are often similar, making differentiation of each difficult. It can be thus concluded that low back pain without occurrence of nerve root symptoms or cauda equina symptoms, is defined as nonspecific low back pain.

Specifically, acute low back pain often occurs due to injury-related elements, such as a minor change of body position, or lifting something carelessly in a half-sitting position. These elements include spraining of intervertebral joints and damage of interspinous ligaments. Also, small repeated movements, which even patients themselves do not notice, sometimes cause acute low back pain. On the other hand, chronic low back pain is often due to structural or physiological fragility in the lumbar part. These cause pain in the lumbar spine and surrounding tissues, which is the pathology of nonspecific low back pain.

In some cases of nonspecific low back pain, the source of pain becomes clear in the course of treatment, or as a result of the treatment, like low back pain due to facet joint, degenerative intervertebral disc, and fibrositis.

Diagnosis

An important point in diagnosis is to differentiate a serious disease without missing it. Serious spinal diseases are spinal tumor and infectious spinal diseases. As diseases in other fields besides orthopedics, a lesion in an organ that exists in the retroperitoneum (kidney, urinary duct, and pancreas), or a lesion in the uterus or the ovary in a female patient, can be accompanied by low back pain. Serious diseases include malignant tumor in the above-mentioned retroperitoneal organs, abdominal aneurysm, and metastasis of gastrointestinal cancer to the lumbar spine. These diseases should be kept in mind while making a differential diagnosis.

1. History-taking

For low back pain, considerable information can be often obtained by history-taking. It is important to ask for details on the onset of the low back pain, and about the presence of disorders in regions other than the lumbar region, such as the abdomen, reproductive organs, and urinary organs. In particular, confirmation on the presence of low back pain at rest is important. When low back pain is present regardless of rest or movement, it should be considered malignant tumor or diseases of internal organs. When pain is present in a lower limb in addition to low back pain, there is a high possibility of radicular pain instead of nonspecific low back pain. Also, as to chronic low back pain, it is important to ask patients' social background, such as the family environment, employment status, and the kind of work. Regarding the medical history, it is necessary to confirm history of injuries, subscribed steroids, presence of motor palsy, etc.

2. Physical findings

Regarding physical findings, it is important to examine not only the lumbar region but also the entire body. Locally, root symptoms and cauda equina symptoms should be checked. Tests should be conducted on muscle strength of the lower limbs, deep tendon reflexes, perception disorder, and the straight leg raising (SLR) for assessing the tension state of nerve roots. The SLR test technique is performed easily. The patient's leg is raised with the knee straight in the supine position. If pain is present on the backside of the thigh, and along the knee and the lower thigh at a raising angle of 70 degree or less, the test result is positive and suggests the presence of a nerve root symptom while the presence of nonspecific low back pain becomes doubtful.[2)]

3. Tests

Diagnostic imaging is useful for diagnosis by exclusion. X-ray examination is useful for low back pain with fever; low back pain that is

present even at rest; low back pain accompanied by weight loss, low back pain that occurs during long-term steroid use, and low back pain with a history of injury. In other words, such imaging tests are useful to make a differential diagnosis regarding tumor, infection, vertebral fracture, etc.

If there are findings suggesting a tumor or infection, blood tests are useful for peripheral blood, C-reactive protein (CRP), alkaline phosphatase, and various tumor markers, or imaging tests such as bone scintigraphy, CT, and MRI are also useful.

In the case of chronic low back pain, various block injections are sometimes conducted, though these are somewhat specialized, to find the source of pain.[3,4] Blocks include trigger point block, intervertebral joint block, posterior medial branch block, and epidural block. Each has not only a diagnostic but also a therapeutic significance. In the practice, caution must be used regarding bleeding tendency and the presence or absence of infection in block segments.

Treatment

1. The point in treatment of nonspecific low back pain

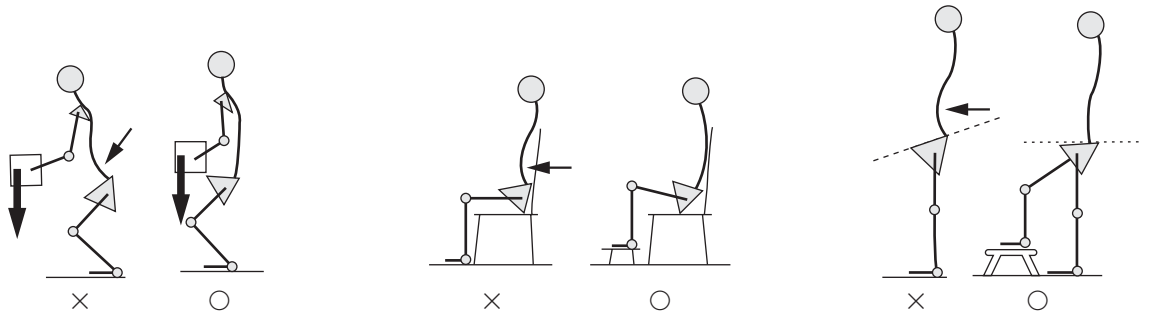
The point in treatment of acute nonspecific low back pain is, first, to eliminate the patient's anxiety by explaining that it is not a malignant disease and no concern is needed in this regard. Also, it is an important point in the treatment to prevent the pain from becoming chronic.

Even in the case of chronic nonspecific low back pain, it is important to eliminate patients' anxiety by explaining that it is not a malignant disease once a diagnosis is established, as in the case of acute pain. In addition, unlike in the acute case, chronic low back pain is associated with major detrimental factors involving not only organic elements but also psychogenic elements due to long-term pain, and this should also be addressed in handling patients with chronic pain. While the conventional goal of the treatment of low back pain has been a complete elimination of the pain, currently the goal has shifted to aiming at social rehabilitation.[5] For this very purpose, it is important to explain to patients in advance how much can be cured, or the expected treatment efficacy, though sometimes judgment may be difficult. Long-term and purposeless hospitalization should be avoided, as it can inhibit improvement of low back pain.

2. Treatment of acute nonspecific low back pain

For acute nonspecific low back pain, symptomatic therapies are the mainstay of treatment, such as local heating/cooling, administration of analgesics, or nonsteroidal anti-inflammatory drugs (NSAIDs). The opinion that has in recent years brought about the most important change in the treatment of acute low back pain is about rest. Conventionally, rest has been considered the best measure for an attack of acute low back pain. Currently, however, giving guidance onto continuing normal activities as much as possible, though a few days' rest may be necessary in some cases, is said to prevent the acute pain from becoming chronic and eventually to speed up social rehabilitation.[6] It is now also said that long-term bed rest causes chronic disorder and makes rehabilitation more difficult.[7] Therefore, it is not necessary to force bed rest, unless the patient is in severe pain. When bed rest is needed, a posture to reduce lumbar lordosis should be taken. In either a supine position or a lateral decubitus position, the patient should rest with the hip joints and knee joints bent. In the supine position, a pillow or the like is needed under the knees.

It is reported that 80 to 90% of acute nonspecific low back pain usually heals within six weeks.[8] Because low back pain is a self-limited disease, if the symptom does not improve even after three or four weeks, further tests are needed to check for a potential serious disease and to find out the cause of the pain.



A. Lifting a heavy object　B. Posture in a sitting position　C. Posture in a standing position

Fig. 2　Instruction on daily living

3. Treatment of chronic nonspecific low back pain

Generally, low back pain that lasts more than three months is called chronic low back pain. In many cases, chronic nonspecific low back pain is due to physiological and structural fragility in the lumbar region, and it is often caused by improper posture, which can be called a living functioning impairment. Specifically, the causes are considered to be weakness of the lumbar spine and muscles surrounding the lumbar spine, which maintain alignment (position and compatibility) of the entire spine, resulting in failure to maintain appropriate posture, instability of the lumbar spine, and excessive burden on muscles and fascia surrounding the lumbar spine.

Also, risk factors for making acute nonspecific low back pain chronic can be sociopsychological issues, such as complaints at work, financial problems, and legal problems, even more than clinical factors.[9] Therefore, the treatment that includes guidance on daily life and psychological approaches is needed.

(1) Guidance on daily life

In the treatment of chronic nonspecific low back pain, guidance on daily life is especially important and constitutes a central role of the treatment.[10] Either at the workplace or at home, the basics of caution in low back pain management are the same.

When lifting a heavy object, the load to the posterior lumbar spinal soft tissues should be reduced by bringing the object as close to the body trunk as possible and shortening the distance between the lumbar part to the object (Fig. 2, A).

For a type of job that requires sitting for long hours, it is recommended to make the knee height higher than the buttock height, or to sit with the knees crossed, to reduce lordosis of the lumbar spine (Fig. 2, B).

In a standing posture, a footstool should be used to prevent excessive lordosis and to reduce muscle fatigue, because this can reduce lordosis of the lumbar spine and the burden on lumbar muscles by keeping the pelvis horizontal (Fig. 2, C). At any rate, the basic caution is to avoid keeping any one posture for long hours.

(2) Drug treatment

Pain is sometimes treated with NSAIDs and muscle relaxants, but for long-term use, it is necessary to choose drugs with low incidence of adverse reactions, such as gastrointestinal disturbance. If a drug is needed, the minimum necessary amount should be administered only for a necessary period, and routine long-term administration of one drug should be avoided.

Insufficient sleep leads to unhealthy feeling, which can sometimes prolong the period of low back pain. Adequate sleep at night is important, and administration of a sleeping pill is also important if there is sleep disorder.

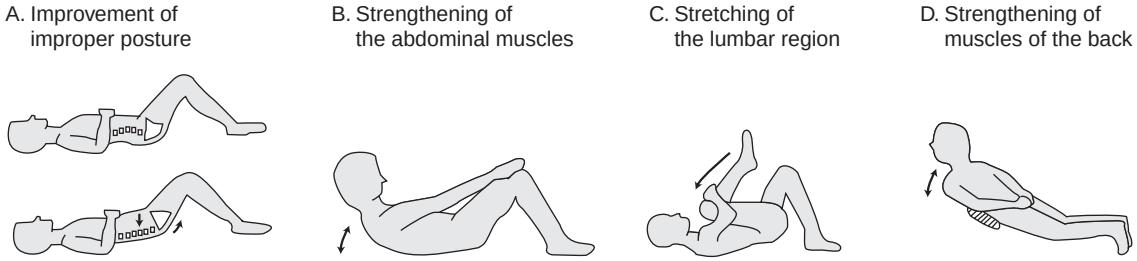


Fig. 3 Exercises for low back pain
(A, B, C, and D were cited from references 10, 11, 12, and 13, respectively.)

(3) Physical therapy

Therapeutic heating and traction are often conducted, but it is not clear if they are effective for chronic low back pain and if they change its natural course. From a viewpoint of relaxation, however, they are means that can reduce pain.

(4) Exercise for low back pain

The purposes of exercise for low back pain are (1) improvement of improper posture, (2) strengthening of the abdominal muscles and muscles of the back, and (3) acquiring flexibility of the soft tissues. There are four types of exercises, as shown in A to D in Fig. 3.

In exercise A,[10] draw up the knees while in a supine position, and in this posture, tighten the abdominal muscles, gluteal muscles, and hamstrings (biceps femoris muscle, semitendinous muscle, and semimembraneous muscle). Relax after fully tightening the msucles while paying attention not to lift the low back. This exercise aims to improve improper posture by reducing lordosis of the lumbar spine. In other words, when lordosis of the lumbar spine is excessive, shearing force on the lumbar spine increases, resulting in greater stress (load) on the posterior lumbar spinal tissues, which causes low back pain. Furthermore, when the abdominal muscles are weak or obesity is present, declination of the pelvis increases, resulting in excessive lordosis of the lumbar spine. Therefore, strengthening of the abdominal muscles prevents an increase in declination of the pelvis.

Exercise B[11] aims to strengthen the abdominal muscles. Strengthening the abdominal muscles reduces lordosis of the lumbar spine, as mentioned earlier, and it also increases abdominal pressure, giving stability of the spine by creating a self-made corset. In this exercise, both the knee joints and the hip joints should be bent. Strengthening of the abdominal muscles does not necessarily require lifting the upper half of the body to the vertical position, and just maintaining the level of having the shoulders slightly lifted from the ground for about five seconds, is sufficient.

Exercise C[12] aims to achieve flexibility of the soft tissues surrounding the lumbar spine by stretching the lumbar part. Excessive lordosis of the lumber spine often indicates the presence of the contracture of paravertebral muscles, inducing low back pain by sudden anteflexion of the trunk. Stretching is important for this reason.

Exercise D[13] aims to strengthen the muscles of the back. Place a pillow under the lower abdominal region to decrease forward curving of the lumbar spine. Using this as a supporting point, lift the back upward. It is not necessary to strongly throw back one's head, and if the pillow is too large, excessive bending of the lumbar spine can occur. Also, pain of the facet joint and the posterior lumbar spinal tissues can be induced, so caution is needed.

Choose two or three types out of exercises A to D, and start with five to 10 repetitions of each exercise twice a day (morning and evening). It is important to gradually increase

types of exercises and frequency according to the condition. Basically, when low back pain is severe, exercise should not be done.

(5) Special therapy

Block therapy has diagnostic and therapeutic meanings, as mentioned in the section on diagnosis. If the pain source can be identified, the following therapeutic measures must be considered instead of continuing the block therapy routinely for a long time. For example, if blocking of posterior medial branches seems effective for chronic low back pain, it is necessary to consider percutaneous cauterization, etc., of their nerve, as a choice of the treatment.

Conclusion

In this report, I described mainly the pathology and the treatment of nonspecific low back pain, which occurs frequently in young and middle-aged people. Nonspecific low back pain involves many factors. Not only structural and physiological abnormalities in the lumbar region but also sociopsychological factors can be a major cause. Complex factors comprising of obesity, overwork, lack of exercise, and mental stress can induce low back pain as a complaint. Since nonspecific low back pain in young and middle-aged people must often be diagnosed by exclusion, a solid differential diagnosis should be performed. In my view, in responding to the complaint of low pack pain, tackling this disease by grasping the whole picture of the patient's life, from the standpoint of a living function-related disease, instead of merely providing anti-inflammatory analgesics, leads to early social rehabilitation.

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Low Back Pain in Japanese Women: Including cases caused by osteoporosis

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Hiroaki OHTA*, Hiroya OKANO, Yoshiko ONOE, Masazumi YAJIMA, Yuko MIYABARA, Remi YOSHIKATA and Takako MIZUNO

**Professor and Chairman, Department of Obstetrics and Gynecology, Tokyo Women's Medical University*

Abstract: Low back pain is an unavoidable symptom among humans because of their bipedal standing posture and is one of the most common complaints of outpatients. Women, in particular, experience low back pain due to various factors throughout their life cycle. Low back pain can be caused by both physiological and pathological factors, including menstrual pain during puberty, pregnancy and parturition during sexual maturity, vague symptoms during the climacteric, and osteoporosis during old age. These factors lead to a higher prevalence of low back pain in females than in males. This review discusses the roles of anatomical and endocrinological factors in the development of low back pain in women. Apart from low back pain associated with pregnancy, most cases of low back pain due to organic disease in middle-aged and elderly women are related to orthopedic or gynecological conditions. The specific underlying diseases and conditions are reviewed. This article also discusses low back pain related to vague symptoms caused by autonomic disorders. This discussion is based on studies of 400 patients with low back pain. Although there was no significant relation between bone mineral density and the presence or severity of low back pain, we confirmed that vertebral fractures associated with osteoporosis cause symptoms such as low back pain and adversely affect patients' quality of life. Low back pain is closely related to life style. The close associations with personality and interpersonal relations require that low back pain is comprehensively diagnosed and treated.

Key words: Low back pain; Gynecological disease; Indefinite complaint syndrome; Osteoporosis; Bone fracture

Introduction

Irrespective of age and sex, about 80% of humans have low back pain some time during their lives. Because humans are bipedal and are subjected to the forces of gravity, the develop-

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ment of low back pain is inevitable. Anatomically, the head is supported by the neck and shoulders, the upper body by the thoracic and lumbar vertebrae, and the trunk by the knees. Increased physical stress that exceeds support strength can lead to symptoms such as shoulder stiffness, low and upper back pain, and knee pain.

Although both sexes experience low back pain, there are several important distinctions. Females have specific physiological characteristics related to pain throughout their life cycle. From menarche and throughout sexual maturity, females have considerable menstrual pain, which may be expressed as low back pain. Pregnancy and parturition are also associated with low back pain. During the climacteric, women experience various types of pain, such as headache, shoulder stiffness, low and upper back pain, knee pain, and lower abdominal pain,[1-3] which comprise a constellation of symptoms referred to as indefinite complaint syndrome. Older age is associated with an increased risk of osteoporosis. The incidence of osteoporosis is much higher in women than in men.[4] Osteoporosis is often initially diagnosed in patients who have low back pain due to fractures.

This article reviews the various causes of low back pain in women. It focuses on low back pain caused by gynecological conditions and discusses the role of osteoporosis.

Causes of Low Back Pain in Females

The incidence of low back pain is far higher in females than in males. This increased incidence is related to the anatomic and endocrinological characteristics of females.

1. Anatomic characteristics

The female pelvis must accommodate a large abdominal cavity, required for pregnancy and parturition. It must also have a distensible and smooth bony birth canal and soft birth canal. The female pelvis is therefore flat and wide. These features are important for pregnancy and parturition, but place muscles and ligaments under considerable physical stress, necessary to maintain balance while walking. This stress can lead to chronic fatigue and low back pain.

The female pelvis is more complex than the male pelvis. The uterus, a female organ, and its appendages such as the ovaries and oviducts have diverse functions. These appendages are suspended from various support systems. Relaxation of these systems causes uterine descent and prolapse, which are also associated with low back pain.

The vaginal orifice is exposed to the external environment and is contiguous with internal organs. These anatomic features increase the risk of ascending infections. Such infections cause inflammation, which can spread from the uterus to surrounding organs and lead to parametritis and related conditions. These conditions are also potential causes of low back pain.

The female pelvis has a well-developed venous plexus and a vascular system prone to hyperemia and congestion. Pelvic hyperemia and congestion can directly cause low back pain.[5] The lymphatic system is also well developed and prone to lymph node swelling. Lymph node swelling can compress the nervous system, causing low back pain.

Tumors of the uterus or ovaries, both benign and malignant, that attain a certain size or are located in specific locations can stimulate surrounding nerves and produce low back pain and other symptoms.

2. Endocrinologic characteristics

Females have hormone cycles controlled mainly by the ovaries and uterus. The menstrual period occurs after the luteal phase of the ovaries and the secretory phase of the uterus. Menstrual bleeding occurs with exfoliation of the endometrium. Menstrual pain can develop during physiological hormonal

Table 1 Causes of Low Back Pain in Middle-Aged and Elderly Women

Gynecological causes 1. Organic causes 1) Positional abnormalities of uterus (uterine descent or prolapse) 2) Uterine tumors (uterine myoma, uterine cancer) 3) Abnormalities of uterine appendages (ovarian tumors) 4) Abnormalities of tissue supporting the uterus (parametritis, etc.) 2. Indefinite complaints caused by autonomic disorders
Orthopedic causes Intervertebral disk hernia, spondylosis deformans, spondylolysis, spondylolisthesis, lumbar spinal canal stenosis, osteoporosis, spinal caries, purulent spondylitis, spinal tumors, spinal cord tumors, coccygeal fractures, spinal metastasis from cancer (breast cancer, thyroid cancer, gastric cancer, lung cancer, uterine cancer), so-called lumbago syndrome
Urological causes Inflammation (pyelonephritis, renal pelvic tumors), calculi, urinary tract obstruction
Psychiatric and neurological causes Depression, psychosomatic disease, hypochondria, neurosis
Internal and surgical causes Appendicitis, myalgia, neuralgia, rheumatism

(From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy* 1996; 73: 286–292)

changes in the absence of organic disease. Endometriosis or uterine myoma can increase the risk of dysmenorrhea. Changes in various organs involved in pregnancy, parturition, and the puerperium, including alterations of the uterus, pelvic joints, muscles, and ligaments, can cause low back pain and other symptoms.

During the climacteric, decreased production of female hormones, interacting with psychic factors and stress, can cause climacteric symptoms and disturbances. Although hormonal changes are not solely responsible for indefinite complaints, the indefinite complaints associated with the climacteric do not occur in the absence of decreased hormone levels. Such indefinite complaints include low back and other types of pain. Endocrinological characteristics thus play an important role in the development of low back pain as well as other types of pain.

Low Back Pain Caused by Gynecological Factors

Potential causes of low back pain in middle-aged and elderly women, excluding pregnancy-related causes, are shown in Table 1.[3] The major causes of low back pain are related to gynecological or orthopedic factors.

1. Positional abnormalities such as uterine descent or prolapse

Middle-aged and elderly women often have positional abnormalities of the uterus, such as uterine descent or prolapse. The major symptoms of this condition include the feeling of an intravaginal or vulvar mass, as well as difficulty in urination or defecation caused by prolapse of the bladder and rectum, organs adjacent to the female genital tract. Increased tension on ligaments or peritoneum supporting the uterus can produce hypogastric discomfort or abdominal pain. Uterine descent usually involves the vaginal portion of the cervix and is intravaginal, but can progress to prolapse of the cervix outside the vaginal orifice. Prolapse of the uterus can progress further to complete uterine prolapse, characterized by downward displacement of the body of the uterus outside the vaginal orifice. Chronic prolapse of the

uterus can cause hydronephrosis due to compression of the urinary tract and passage disturbances, associated with low back pain.

Retroflexion of the uterus was previously considered a common cause of low back pain associated with positional abnormalities of the uterus. Corrective surgery was even performed in young infertile women. Currently, however, retroflexion of the uterus is not regarded to be a cause of either low back pain or infertility.

2. Uterine tumors such as uterine myoma and uterine cancer

Uterine myoma, a benign tumor arising in the uterus, is rarely a direct cause of pain because most myomas arise in the body of the uterus. However, myomas originating in certain locations can produce pain. Subserosal myomas developing in the broad ligament of the uterus (intraligamentous myomas) or myomas arising in the uterine cervix or vaginal portion of the cervix can present with low back pain caused by compression of the surrounding nerves and urinary tract and produce symptoms such as feeling of an abdominal mass.

Early uterine cancer is not associated with low back or other types of pain, but advanced disease with tumor invasion of surrounding tissue and direct stimulation of nerves can cause low back pain and other symptoms. Tumor metastasis to the spinal column can produce severe low back pain.

3. Abnormalities of uterine appendages, such as ovarian tumors

Ovarian tumors, irrespective of benign or malignant status, present with the features of intraligamentous tumors, similar to uterine myomas. Very large tumors can cause abdominal pain as well as low back pain due to compression of surrounding nerves or the urinary tract. Ovarian tumors may cause torsion, and rupture can produce sudden abdominal and low back pain. Torsion can cause tumor necrosis, and rupture with release of the contents can result in peritonitis. These conditions are also associated with pain.

Advanced ovarian cancers directly invade the uterus, ovaries, colorectal region, and ureters, causing urinary tract disturbances and hydronephrosis. Metastasis to bone can cause low back pain.

Acute inflammation of uterine appendages, particularly the oviducts, can cause adnexitis with fever and lower abdominal pain. Lower back pain also sometimes occurs. When appendages adhere to the posterior surface of the uterus because of chronic inflammation, low back pain as well as abdominal symptoms such as lower abdominal discomfort and abdominal fullness sometimes develop.

4. Abnormalities of uterine support tissue, such as parametritis

Connective tissue along the uterine cervix is referred to as parametrium. Inflammation of this tissue is called parametritis. Along with adnexitis, parametritis is a common inflammation of intrapelvic organs. Parametritis-related abscesses fill one side of the pelvic category and compress the uterus, bladder, and colorectum on the contralateral side, leading to fever as well as severe lower abdominal pain and low back pain.

Low Back Pain as an Indefinite Complaint Syndrome

Our department surveyed the prevalence and severity of low back pain in 400 women attending our climacteric outpatient clinic (mean age, 49.2 years; range, 22–80 years) (Figs. 1–3). These subjects did not include women with distinct evidence of osteoporosis or gynecological or orthopedic diseases related to low back pain. This survey indicated that about 70% of women in their 30s to 60s have "low back pain," irrespective of their specific age group. About 35% of these women have severe low back pain interfering with daily activities. The prevalence of low back pain increases gradually between the ages of 30 and

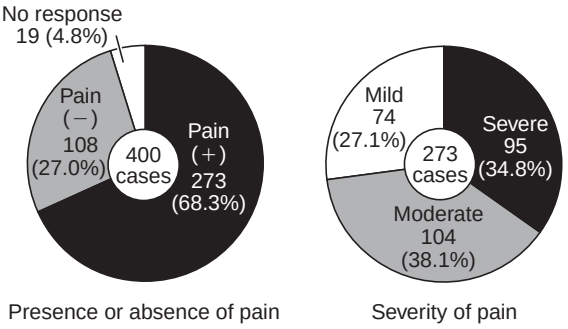

Fig. 1 Presence or absence and severity of low back pain (From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy* 1996; 73: 286–292)

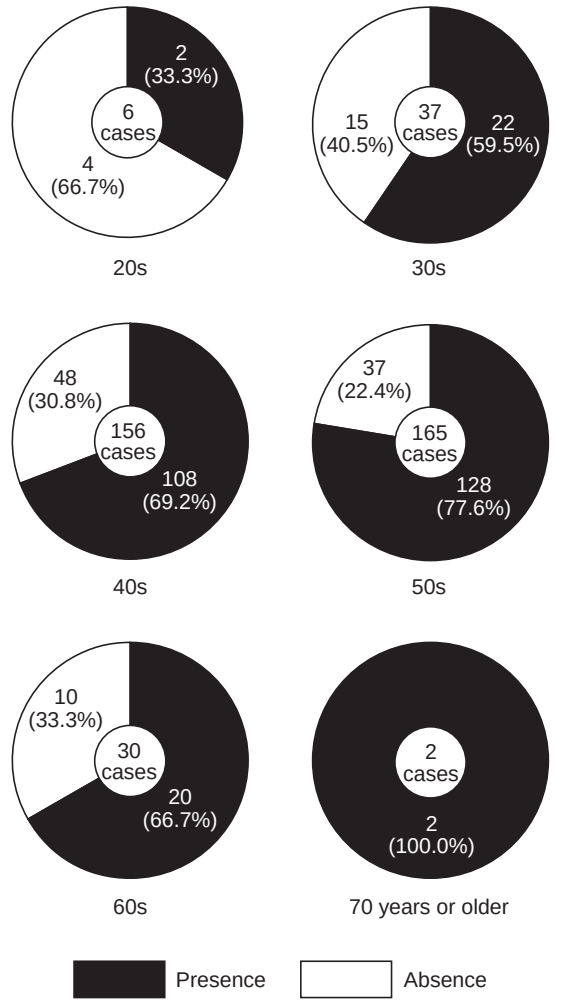

Fig. 2 Presence or absence of low back pain according to age group
(From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy* 1996; 73: 286–292)

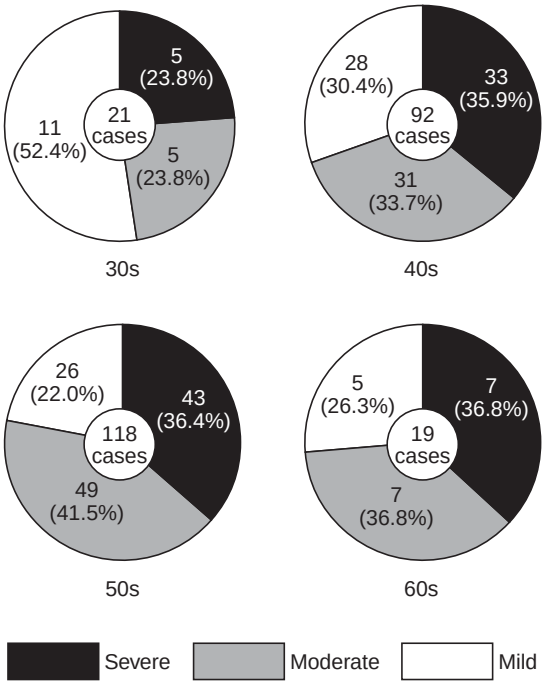

Fig. 3 Severity of low back pain according to age group
(From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy* 1996; 73: 286–292)

39 years and reaches a peak value between 50 and 59 years. There was no clear-cut difference in disease status among women in their 30s to 50s. However, the prevalence of severe low back pain was lower in women in their 30s than in older women. In conclusion, the prevalence of low back pain was slightly lower and that of severe cases was lower in women in their 30s than in older women. However, there was no remarkable difference in the prevalence or severity of low back pain as compared with women in their 40s to 50s.

Low back pain associated with the indefinite complaint syndrome is attributed to fatigue of ligaments and muscles surrounding the spinal cord, caused by activities of daily life. Such symptoms cannot be detected on imaging studies or blood tests and are considered transient, extremely mild, reversible changes. In terms of Chinese medicine, fatigue results from abnormalities in the distribution of intrapelvic

Table 2 Diagnostic Criteria for Pain Disorder (DSM-IV)

A. Pain in one or more anatomical sites is the predominant focus of the clinical presentation and is of sufficient severity to warrant clinical attention.

B. The pain causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

C. Psychological factors are judged to have an important role in the onset, severity, exacerbation, or maintenance of the pain.

D. The symptom or deficit is not intentionally produced or feigned (as in factitious disorder or malingering).

E. The pain is not accounted for by a mood, anxiety, or psychotic disorder and does not meet the criteria for dyspareunia.

Code as follows:

307.80 Pain disorder associated with psychological factors: Psychological factors are judged to have the major role in the onset, severity, exacerbation, or maintenance of the pain. (If a general medical condition is present, it does not have a major role in the onset, severity, exacerbation, or maintenance of the pain.) This type of pain disorder is not diagnosed if criteria are also met for somatization disorder.

Specify if:

Acute : Duration of less than 6 months

Chronic: Duration of 6 months or longer

307.89 Pain disorder associated with both psychological factors and a general medical condition: Both psychological factors and a general medical condition are judged to have important roles in the onset, severity, exacerbation, or maintenance of the pain. The associated general medical condition or anatomical site of pain (see below) is coded on Axis III.

Specify if:

Acute : Duration of less than 6 months

Chronic: Duration of 6 months or longer

Note: The following is not considered to be a mental disorder and is included here to facilitate differential diagnosis.
Pain disorder associated with a general medical condition: A general medical condition has a major role in the onset, severity, exacerbation, or maintenance of the pain. (If psychological factors are present, they are judged not to have a major role in the onset, severity, exacerbation, or maintenance of the pain.) The diagnostic code for the pain is selected based on the associated general medical condition if one has been established (see Appendix G) or on the anatomical location of the pain if the underlying general medical condition is not yet clearly established—for example, low back (724.2), sciatic (724.3), pelvic (625.9), headache (784.0), facial (784.0), chest (786.50), joint (719.40), bone (733.90), abdominal (789.0), breast (611.71), renal (788.0), ear (388.70), eye (379.91), throat (784.1), tooth (525.9), and urinary (788.0).

(From *Diagnostic and Statistical Manual of Mental Disorders, 4th ed.: DSM-IV*. American Psychiatric Association, Washington, D.C., 1994.)

blood flow and reflects "stagnant" blood flow. In addition to such undetectable organic changes, indefinite complaints arising from so-called autonomic disorders due to climacteric disturbances may also be involved as psychic factors. This assumption is supported by the following five findings:

1. Low back pain is one of the most common symptoms of climacteric disturbances.[6)]
2. The Kupperman menopausal index,[7)] long used to diagnose climacteric disturbances and evaluate treatment response, includes articular and muscular pain. Low back pain would fall under this category.
3. The classification of autonomic symptoms associated with climacteric disturbances includes low back pain as a sensory and muscular system symptom.
4. Low back pain or upper back pain is included as a skeletal/muscular symptom used to evaluate psychosomatic status.
5. About 80% of patients with chronic low back pain are depressed, indicating that psychic pain is closely related to physical pain. The American Psychiatric Association has thus established diagnostic criteria for chronic pain (physically expressed painful disorders) (Table 2).[8)]

These findings strongly suggest that low back pain is related to indefinite complaints caused by autonomic disorders.

Low Back Pain and Osteoporosis

Low back pain has long been considered a clinical symptom of osteoporosis. Examina-

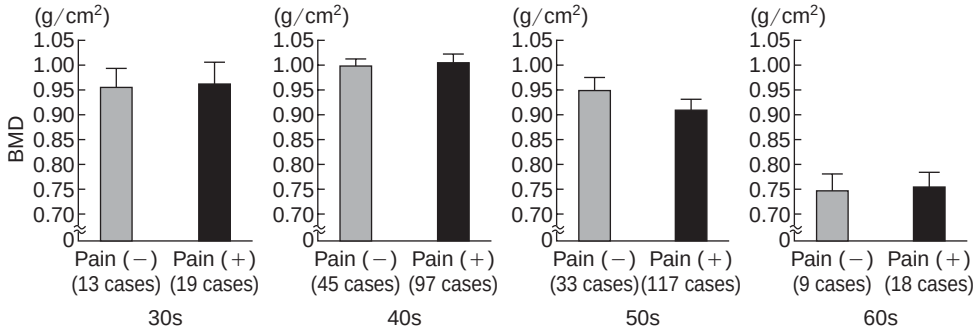

Fig. 4 Lumbar bone mineral density according to age group.
(From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy* 1996; 73: 286–292)

tions for osteoporosis are done in patients who have low back pain. However, the World Health Organization (WHO) diagnostic criteria and the Japanese diagnostic criteria for primary osteoporosis[10–12] do not include the presence or absence of low back pain.

We therefore studied whether the presence and severity of low back pain are related to lumbar bone mineral density as assessed by dual-energy X-ray absorptiometry (DXA) or to the severity of osteoporosis as evaluated by radiographic examination of the spine.[3] We found that the presence of low back pain was not related to either lumbar bone mineral density or to osteoporosis. There was also no significant relation between low back pain and lumbar bone mineral density in any age group (Fig. 4). Similar results were obtained for the relation between the severity of low back pain and the level of bone mineral density. These results indicated that low back pain does not necessarily imply low bone mineral density or a diagnosis of osteoporosis (i.e., a risk of osteoporosis). Our findings are in accord with the diagnostic criteria for osteoporosis proposed by the WHO[9] and the Japanese Society for Bone and Mineral Research.[10–12]

Fractures associated with osteoporosis are known to present with low back pain. Fractures accompanied by pain are symptomatic and are referred to as clinical fractures. Asymptomatic fractures that are initially diagnosed on radiographic examination are called morphometric fractures. Old fractures are referred to as prevalent fractures, and new fractures as incident fractures. Fractures of the spinal vertebrae initially develop in patients in their 50s and increase gradually after 70 years of age. The lifetime fracture risk in Japanese women is 40%, similar to that in white women. About one-third of women with spinal vertebral fractures experience pain. Fractures in the other two-thirds are asymptomatic and are referred to as silent disease.[13]

The mechanism leading to pain may be direct, with pain occurring at the fracture site, or indirect, with pain resulting from fracture-related deformity. Progression of osteoporosis leads to more fractures. The development of hunchback or humpback is consistently accompanied by low and upper back pain. Compression of the spinal process region induces pain and increases tension on ligaments located between spinal processes. The site of ligament adhesion to bone becomes inflamed, thus causing pain. Hunchback or humpback is associated with spinal kyphosis. Muscles responsible for extension of the back are therefore constantly overextended, concurrently causing fatigue-induced or ischemic low back pain. Such low back pain is characterized by decreased tension on back muscles on elbow or knee presentation

Table 3 Starting Point of Therapy for Osteoporosis (Fracture prevention, particularly of vertebral fractures)

1. Initial fracture site present
2. Vertebroplastique attempted, but no cure
3. Disturbance of organ function
4. Incidence of osteoporosis-related fractures higher than that in common sites of fracture, such as the femoral neck and distal radius
5. Pain frequently delayed
6. Psychological disadvantages caused by cosmetic problems

(From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy*1996; 73: 286–292)

Table 4 Symptoms Associated with Spinal Deformity

Cervico-omo-brachial syndrome
Nervous system: Symptoms mimicking those of cervical spondylosis, drop attacks, cervical vertigo
Muscular system: Chronic cervical pain, brachial pain
Symptoms of low and upper back
Chronic pain and fatigue of long back muscles, gluteal muscles, or tensor fascia lata muscles, nocturnal convulsions of lower extremities
Respiratory symptoms
Hypoventilation caused by humpback
Gastrointestinal symptoms
Chronic reflux esophagitis, diaphragmatic hiatal hernia, constipation, flatulence, hemorrhoids, anorexia, vomiting sub-ileus
Change in appearance
Loss of feminine feeling

(From Ohta, H. *et al.*: Low back pain in middle-aged and elderly women. *Obstetrical and Gynecological Therapy* 1996; 73: 286–292)

Table 5 Decrease in QOL Caused by Osteoporosis-Related Fractures

	QOL	
	After 1 year	After more than 1 year
Healthy adults	1.0000	1.0000
Femoral neck fracture	−0.4681	−0.1695
Vertebral fracture*	−0.0502	−0.0490
Distal radius fracture	−0.0464	−0.0060

*Decrease in QOL caused by vertebral fracture is continuous.
(Modified from Kanis, J.A. *et al.*: The burden of osteoporotic fractures: A method for setting intervention thresholds. *Osteoporos Int* 2001; 12: 417–427)

while bending the back posteriorly. Intramuscular pressure thus decreases and blood flow increases, thereby improving or eliminating low back pain.

Most fractures associated with osteoporosis accompanied by low back pain involve the body of vertebrae. The positioning of vertebral fractures resulting from osteoporosis is shown in Table 3. This table clearly shows the importance of vertebral body fractures in deciding the starting point of treatment for osteoporosis.

The development of hunchback or humpback requires caution because these conditions can present with an extremely diverse range of symptoms (Table 4) in addition to low and upper back pain. Once vertebral fractures develop, the decrease in the quality of life (QOL) after 1 year is about one-tenth of that associated with femoral neck fractures and is similar to that associated with distal radius fractures. Subsequently, however, the decrease in QOL is one-third of that at 1 year in patients with femoral neck fractures and two or three-tenths of that at 1 year in patients with distal radius fractures. In contrast, QOL does not change appreciably in patients with vertebral fractures. These fractures are thus characterized by a trend toward delayed recovery of QOL (Table 5).[14)]

Concluding Remarks

Low back pain in females can be caused by gynecological diseases as well as by indefinite complaint syndrome and osteoporosis. Treatment of low back pain is difficult because examinations often reveal no evidence of disease and psychosomatic factors are frequently involved. Because there is no single cause, women who successfully undergo surgery for gynecological disease sometimes continue to have pain. Some cases of chronic low back pain are therefore of unclear etiology and are referred to as so-called lumbago syndrome.

Low back pain is closely related to lifestyle and can be affected by human and social fac-

tors, such as individual personality and interpersonal relations at home or the workplace. Low back pain is therefore a condition of modern society. Treatment requires comprehensive assessment of patients including psychological factors and living environment as well as clinical symptoms. Providing patients with support to allow them to understand the underlying causes of low back pain is essential for a successful treatment outcome.

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Low Back Pain Due to Degenerative Disease in Elderly Patients

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Hiroshi YAMAMOTO

Professor Emeritus, Department of Orthopaedic Surgery, Kochi Medical School

Abstract: Low back pain in elderly individuals arises from age-related changes in lumbar spine structures, and these changes are closely associated with the lifestyle of the patient. Low back pain is classified into organic pain associated with organic disorders in lumbar spine structures (spondylolisthesis, spinal stenosis, osteoporotic vertebral fracture, etc.) and functional pain associated with no lesions other than physiological age-related changes. While the former should be treated with appropriate intervention after accurate diagnosis, the latter requires therapeutic exercise and guidance for their lives.

Key words: Low back pain; Elderly patients; Exercise; Lumbar degenerative disease

Epidemiology of Low Back Pain in Elderly Patients

Reflecting the increasing size of the elderly population, we are faced with a constant increase in the prevalence of low back pain and neurological symptoms in the lower limbs among senior citizens. The development of low back pain is strongly associated with postural load conditions reflecting the lifestyle of the patient, in addition to the age-related changes in lumbar spine structures.

The authors studied the prevalence of low back pain among individuals aged 65 years or more in Kochi Prefecture, and the results are shown in Table 1. Of the 745 randomly selected elderly individuals living in the urban area of Kochi City, 54% reported having low back pain (the percentage of those who had low back pain during the preceding month). On the other hand, the prevalence of low back pain exceeded 70% among the 703 elderly persons working in rural/mountainous areas. The prevalence was as low as 42% among those staying in a health institution for the elderly in the city. These results indicate that low back pain is closely associated with patient lifestyle.

Lumbar Disorders in Elderly Patients

The lumbar spine structures involved in the development of low back pain are interverte-

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Table 1 Prevalence of Low Back Pain in Elderly Individuals (aged≧65)

		Subjects (persons)	Low back pain		
			(+) at the time of the study	(+) during the past month	None
Urban	Kochi City	745	13%	54%	46%
	Health institution for the elderly	45	13	42	57
Rural/mountainous	Rural (Tai)	302	43	72	14
	Rural (Hayama)	129	49	76	24
	Mountainous (Higashi Toyonaga)	272	50	77	20

(Quoted from Masaaki Ando, Hiroshi Yamamoto *et al.*, *Journal of the Western Japanese Research Society for Spine*, 1986; 12(1): 172–175.)

bral disk cartilages, intervertebral joints, tendons, and muscles. When the sensory receptors in these structures receive nociceptive stimuli, they trigger a pain reaction in the pain sensation system, including both at the peripheral and the central levels. Inappropriate posture, irregular movement of the lumbar vertebrae, and reduced or imbalanced muscle strength enhance the nociceptive stimuli. Motion restriction due to pain leads to the contracture of intervertebral joints and the atrophy of the other lumbar spine structures, resulting in a vicious circle of pain.

Among changes in lumbar spine structures, age-related degeneration of intervertebral disk cartilages and that of intervertebral joints are common causes of low back pain. Kirkaldy-Willis classified the development of low back pain into the following 3 stages:

(1) **Dysfunction**: Ruptures occur in the intervertebral cartilages, and early lesions such as minimal damage to the intervertebral joints and mechanical inflammation develop.

(2) **Instability**: The function of the intervertebral disks is disrupted, progression of the degenerative processes is seen in the intervertebral joints, instability develops in the motor functional unit, and clinical symptoms such as low back pain and lower limb neurological symptoms become severe.

(3) **Restabilization**: Motion is restricted due to spur formation on the vertebral bodies and thickening and deformation of intervertebral joints. At this stage, the severity of low back pain decreases despite the reduced range of motion of the lumbar spine. However, morbidity may result from lumbar spinal canal stenosis.

1. Lumbar spinal canal stenosis

Lumbar spinal canal stenosis involves the age-related degeneration of the vertebral bodies, vertebral arches, and intervertebral disks, which comprises the spinal canal. This degeneration causes deformation or slipping of the vertebrae, resulting in the narrowing of the space containing the cauda equina and nerve roots, hence causing neurological symptoms of the lower limb and low back pain. A characteristic symptom of lumbar spinal canal stenosis is claudication, in which prolonged continuous walking and standing may cause excessive dynamic loading on the spinal canal, inducing symptoms of the lower limb. The factors inducing lumbar spinal canal stenosis are summarized in Table 2. While the primary factor is the age-related changes in the lumbar spine structures, attention should be paid to the postural factor, in which backward bending of the lumbar spine due to weakening of trunk muscles may cause narrowing of the spinal canal and accelerate deformation of the posterior structures.

Table 2 Factors Causing Lumbar Spinal Stenosis

1. Age-related changes in lumbar spine structures
2. Postural factors: weakening of trunk muscles (increased load on spinal canal)
3. Segmental instability starting in middle age: degenerative spondylolisthesis
4. Spondylolytic spondylolisthesis, previous lumbar surgery, etc.

2. Osteoporotic fracture

Reduced bone mass in elderly individuals may result in the development of osteoporosis and an increased risk of non-traumatic osteoporotic fracture of the spine. The pain from osteoporotic fracture arises abruptly and is severe. The fracture usually heals, and the pain decreases within 2 or 3 months. If pain continues for more than 2 or 3 months, pseudoarthrosis of the vertebral body is suspected. This possibility should be studied by examining whether or not there is a difference in the anterior height of the injured vertebral body between standing lateral and supine lateral plain radiographs.

Figure 1 shows lumbar spine disorders and their symptoms in elderly patients. The symptoms reported by elderly patients include (i) low back pain, (ii) kyphotic and scoliotic spine deformity, and (iii) neurological symptoms of lower limb accompanying spinal stenosis. These 3 categories of clinical symptom arise from the above forms of the disease.

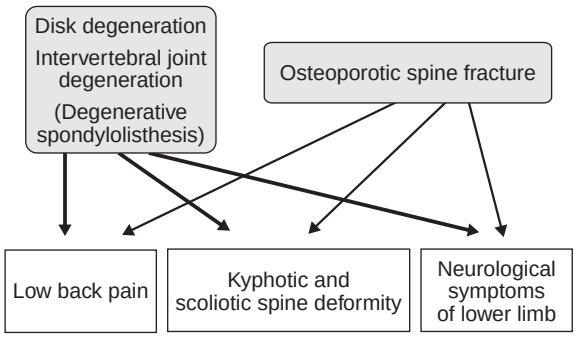


Fig. 1 Lumbar spine disorders in elderly patients

Diagnostic Tips

The diagnosis of lumbar disorders in elderly patients should be based on careful history taking and physical findings. It is particularly important to confirm what kind of activities of daily living induce and eliminate the clinical symptoms. It is necessary to examine the deformity of the lumbar spine, the range of motion, the presence of neurological symptoms of the lower limb in response to postural loading, and physical findings such as neurological findings in the lower limbs.

MRI is an effective method of imaging diagnosis, and can provide definitive evidence of disk herniation, spinal stenosis, and osteoporotic spine fracture. In the case of osteoporotic spine fracture, a low intensity area on a T1 enhanced image indicates a new fracture.

Table 3 lists the important points to be considered in diagnosing low back pain in elderly patients. While imaging diagnosis in elderly patients may provide objective evidence, it has the drawback of frequent false-positive findings. Therefore, even if abnormalities are detected on MRI images, it should not necessarily be concluded that the clinical findings are attributable to these abnormalities. A key in selecting the treatment method can also be obtained from careful history taking, symptomatic analysis of pain, examination of motion-induced symptoms observed while walking side-by-side with the patient, detailed analysis of neurological findings, and functional diagnosis such as nerve block and electrophysiological examination. In all cases, it is important to obtain and evaluate detailed information on the nature of the pain in the lower back and lower limbs, as well as information on how

Table 3 Important Points in Diagnosing Low Back Pain in Elderly Patients

- MRI and other imaging methods tend to show false-positive findings.
- Physicians should not necessarily conclude that clinical symptom is attributable to abnormal findings on the images.
- Careful history taking and physical findings are important.
- Functional diagnosis sometimes provides evidence.

Table 4 Treatment of Lumbar Spine Disorders in Elderly Patients

1. Conservative therapies (first choice)
   - Medication: NSAIDs, muscle relaxants (e.g., eperisone hydrochloride)
   - Local block therapy
   - Physical therapy: Physiotherapy (heat, light, brace, etc.), therapeutic exercise
2. Surgical therapies (second choice)
   - Decompression
   - Spine fusion
   - Decompression and fusion

the pain is related to the activities of daily living, to decide the method for treatment that will improve the patient's quality of life.

Treatment

1. Basics of treatment of lumbar spine disorder in elderly patients

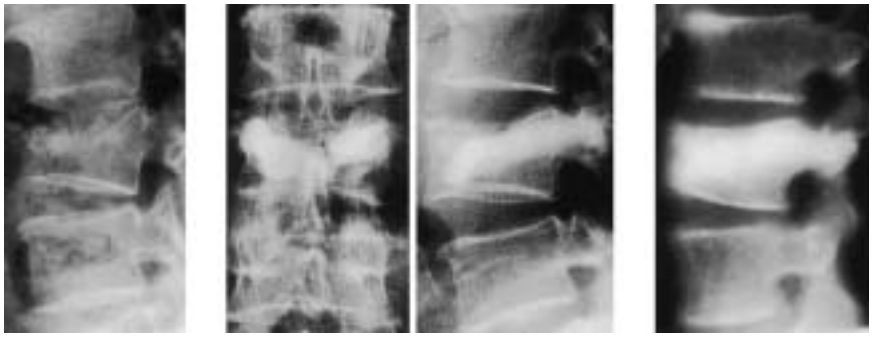
The first choice of treatment for elderly patients with lumbar spine disorder is conservative therapy. As shown in Table 4, the first-line conservative therapy is medication (oral, transdermal, suppository, or intravenous). Oral medication for low back pain basically involves the use of nonsteroidal anti-inflammatory drugs (NSAIDs). Because NSAIDs tend to develop hepatic, renal, and gastrointestinal complications in elderly patients, it is necessary to consider the possible adverse effects of the prolonged NSAID use. Prostaglandins are used for lumbar spinal canal stenosis with claudication. Depending on the symptoms and diagnosis, local intervertebral joint block, nerve root block, and extradural block can also be used. Local block techniques, however, are not effective unless the needle is placed accurately, and a risk of complication accompanies these techniques.

Bed rest and corsets are prescribed to stabilize the lumbar region. Care should be taken, however, because prolonged bed rest and prolonged corset use weakens the trunk muscles of the patients with degenerative disease in the lumbar region. Patients with lumbar degenerative spondylolisthesis and those with lumbar degenerative scoliosis may be prescribed braces for use during work and for protection against postural loading.

A condition that requires utmost caution is osteoporotic compression fracture of the vertebral body. Fracture should be suspected when the patient complains of severe pain and when strong pain is felt on moving from a lying position to a sitting position or vice versa. These cases should be diagnosed appropriately and treated by resting the affected part.

2. Surgical treatment and its indications

Surgical treatment is often indicated for lumbar spinal canal stenosis in elderly patients with lumbar disorders. For patients who develop claudication when moving over a distance of



Initial examination | Shortly after calcium phosphate bone paste injection | 24h after injection (tomography)

Fig. 2 Osteoporotic compression fracture of the lumber vertebral body (L3, male, aged 76)
The extent of wedge deformation is 64% (left), 85% (middle), and 79% (right).
(Quoted from Hiroshi Yamamoto *et al.*, *Journal of the Japanese Clinical Orthopaedic Association*, 1999; 34(4): 435–442.)

less than 200m, show progression of symptoms, and do not respond to prostaglandin therapy within about a month and a half, surgical treatment based on the results of re-evaluation should be considered. If surgery is performed too late, recovery may be poor due to progression of irreversible changes. Close cooperation between primary care physicians and specialists is required in this respect.

When decompression is performed for lumbar spinal canal stenosis, it is important to avoid unnecessarily extensive decompression, because elderly patients tend to show false-positive results. It is necessary to determine responsible spinal levels as closely as possible through the accurate analysis of neurological findings and the possible use of nerve blocks, in addition to imaging diagnosis.

Spine fusion is sometimes performed on patients with spondylolisthesis when the lesions are dynamic, and the treatment is combined with instrumentation in elderly patients who retain sufficient bone mass and activity. However, many patients with lumbar spine slippage do not require spine fusion if the lesions do not involve considerable dynamic factors. Treatment for these patients should be planned carefully to avoid excessive surgical intervention.

The author uses transpediculate injection of calcium phosphate bone paste (Fig. 2), even in fresh cases of osteoporotic spine fracture, if there is a significant risk of progressive collapse or there is evidence of spinal pseudoarthrosis and persistent pain when making positional changes.

3. Therapeutic exercise for functional low back pain

Cases of chronic low back pain are considered to be functional if there are no neurological symptoms in the lower limbs, and if imaging diagnosis does not reveal evident organic abnormalities other than intervertebral joint deformation and disk degeneration that are proportional to the patient's age. In addition to slight kyphosis and a reduced range of motion, these patients often show weakness of the trunk muscles including the back and abdominal muscles. In such patients, prolonged exertion and an active lifestyle may cause low back pain. The author and his colleagues conducted trunk muscle training in elderly patients with functional low back pain, and confirmed that low back pain improves as the trunk muscles strengthen, particularly the back muscles (Fig. 3). Therapeutic exercise should be prescribed based on specialist evaluation of the pain reduction achieved by medication.

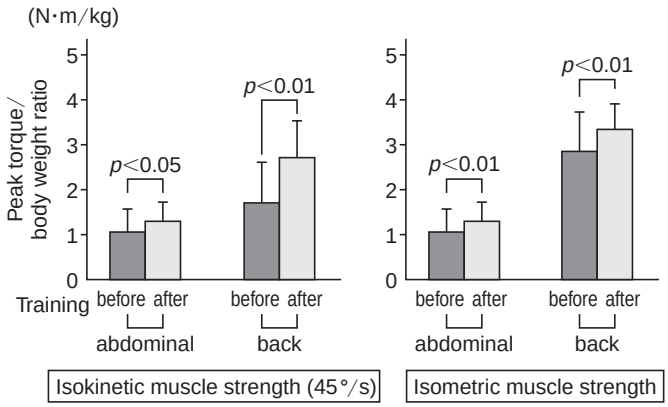


Fig. 3 Trunk muscle strength in middle-aged patients with chronic low back pain before and after training

The subjects were patients with low back pain without evidence of organic disorder in the lumber spine.

(Quoted from Norihiko Handa, Hiroshi Yamamoto *et al.*, *Exercise Therapy and Physiotherapy*, 1997; 8(1): 63–69.)

While low back pain is related to the functional deterioration of lumbar spine structures, paying attention to posture and continuing physical exercise in daily living can improve the health of the lumbar region. I hope to help citizens lead active, fruitful lives through practicing appropriate exercise since all citizens may benefit from this practice, irrespective of age.

Diagnosis and Treatment of Lumbar Spinal Canal Stenosis

JMAJ 46(10): 439–444, 2003

Katsuro TOMITA

Department of Orthopedic Surgery, Kanazawa University

Abstract: Lumbar spinal canal stenosis is a syndrome of neurological symptoms that appear due to compression of the cauda equina nerve bundle and nerve roots, as a result of narrowing of the lumbar spinal canal through which the spinal nerve bundle passes, and accompanies the degeneration that occurs with aging. Specific causes related to narrowing and compression are degenerative bulging of an intervertebral disk; thickening of a vertebral arch, an apophyseal joint or the yellow ligament; and spondylolisthesis. All these factors, which are due to various diseases, cause narrowing of the spinal canal, resulting in compression of the spinal nerves inside the canal and inducing neurological symptoms. The main symptoms are sciatica and intermittent claudication that are treated with therapies based on the severity of the stenosis. These range from conservative treatment provided at pain clinics etc. and rehabilitation, to surgical treatment. Especially in recent years, lumbar spinal canal stenosis has been treated increasingly in the elderly.

Key words: Lumbar spine; Low back pain; Spinal canal stenosis; Intermittent claudication; Sciatica; Nerve root block

What is Lumbar Spinal Canal Stenosis?

Lumbar spinal canal stenosis is a syndrome of symptoms that appear due to compression of the cauda equina nerve bundle and nerve roots, as a result of narrowing of the lumbar spinal canal, and accompanies the degeneration that occurs with aging (Figs. 1 to 3). Specific causes related to narrowing and compression are bulging of an intervertebral disk; thickening of a vertebral arch, an apophyseal joint or the yellow ligament; and spondylolisthesis.

These factors, due to various diseases, cause stenosis of the spinal canal, resulting in compression of the spinal nerves inside the canal, thus inducing neurological symptoms. Especially in recent years, lumbar spinal canal stenosis has been treated increasingly in the elderly.

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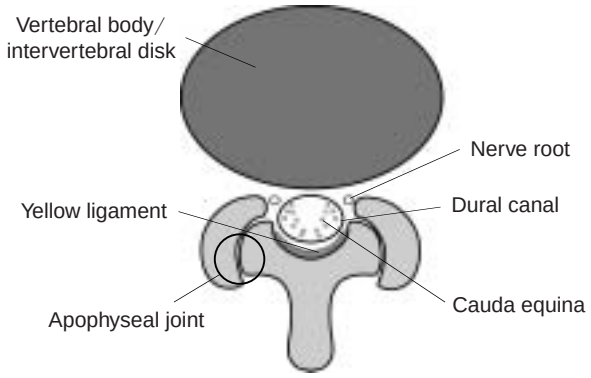

Fig. 1 Structure of the lumbar spinal canal

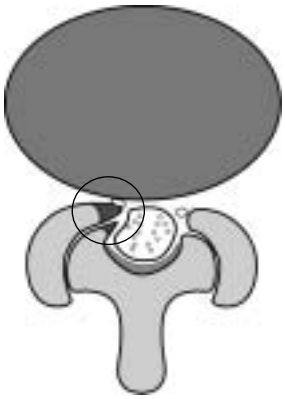

Fig. 2 Intervertebral disk-level stenosis (nerve root type)
The nerve root is compressed by a bone spur generated by deformity of an apophyseal joint.

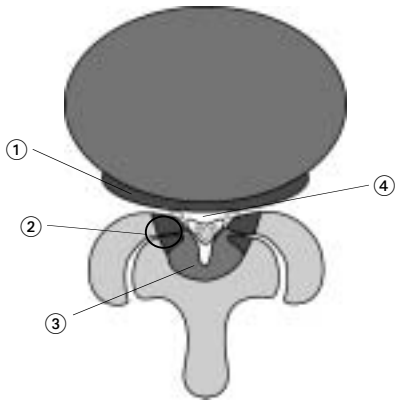

Fig. 3 Intervertebral disk-level stenosis (cauda equina type)
(1) Deformed and bulging intervertebral disk
(2) Bone spur at the apophyseal joint part
(3) Thickened yellow ligament
(4) Compressed and flattened dural canal and nerve root

Table 1 Differentiation of Intermittent Claudication

		Neurogenic		Vascular
		Nerve root type	Cauda equina type	
Induction of claudication		Walking (symptoms reduced with a lordotic position)		Walking (symptoms unrelated to posture)
Symptoms	Character	Mainly pain	Abnormal sensations such as numbness and cold sense	Mainly pain, cold sense
	Region	Mostly unilateral	Mostly bilateral	Mostly unilateral
	Paralytic symptoms	Single-level motor/perception disturbance	Diversified, such as multi-level motor/perception disturbance	None
Physical findings	Neurological findings	Single-level irritation/deficiency symptom	Bilateral Achilles tendon hyporeflexia	None
	Arterial pulse on dorsal foot	Normal	Normal	Deficient or weakened
Decisive supportive diagnostic method		MRC, CT, myelography, radiculography, block	MRI, myelography, CT	Arteriography

Fig. 4 A case of nerve root-type intermittent claudication (simple X-ray)
Female, aged 68; a case with nerve root-type intermittent claudication in the right leg. Deformity in the lumbar spine is noted on a simple X-ray image (spur formation, intervertebral space reduction, etc.)

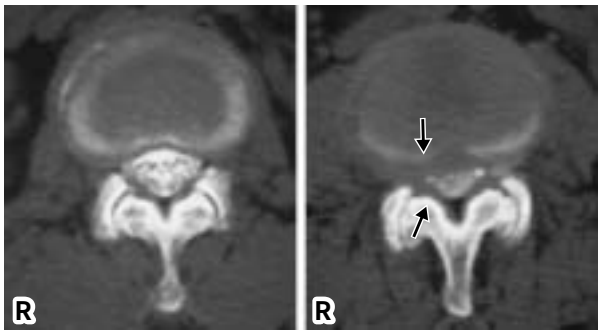

Fig. 5 A case of nerve root-type intermittent claudication (myelography CT)
Left: At the normal level, no stenosis of the dural canal is noted.
Right: At the L4/5 level, the dural canal is compressed significantly on the right side, due to protrusion of an intervertebral disk and thickening of the yellow ligament.

What Kind of Clinical Symptoms Appear?

The main symptoms of lumbar spinal canal stenosis are chronic, so-called "sciatica" (low back pain, leg pain, and feeling of numbness) that occurs on walking, and neurogenic intermittent claudication. These symptoms gradually progress over time alternatively deteriorating and improving. In other words, this disease is not accompanied by severe symptoms of nerve irritation or deficiency phenomenon, as with disk herniation; or by severe pain at rest, as with metastatic cancer in a vertebra or pyogenic spondylitis.

1. Neurogenic intermittent claudication

Neurogenic intermittent claudication is pain, numbness, and weakness in the legs that occur and intensify on walking (caused by the load of the body weight on the spine), finally resulting in an inability to step forward. Furthermore, these symptoms improve by bending forward (lordotic position), whereafter the patient can walk again, which is a characteristic of this disease. (A patient can ride a bicycle for a long time if assuming a lordotic posture.) Sensory march is also noted, whereby abnormal sensation travels from the foot to the buttocks or perineal region, or descends from the buttocks to the lower limbs, with walking. In some cases, bladder and rectal disturbances, such as an increased urge to urinate, incontinence, and penile erection, occur on walking.

2. Differentiation of intermittent claudication

Neurogenic intermittent claudication must be differentiated from vascular intermittent claudication (arteriosclerosis obliterans and Buerger's disease) (Table 1). Points of differentiation are improvement of the symptoms by assuming a lordotic posture, findings on palpation of the plantar arteries, and measurement of the upper limb/lower limb blood pressure ratio. Neurogenic intermittent claudication can be classified into the following three groups based on the clinical symptoms and the state of stenosis:

1) Nerve root-type intermittent claudication is a single-root disorder, and it is characterized by pain and numbness of the same lower limb as the responsible nerve root (Figs. 2, 4, 5). Most cases of lumbar spondylosis belong to this group.

Fig. 6 A case of cauda equina-type intermittent claudication (myelography)
Female, aged 78; a case with cauda equina-type intermittent claudication. Deformity in the lumbar spine (spur formation, intervertebral space reduction, etc.) is noted.
Severe stenosis is noted at L4/5 on a myelogram.

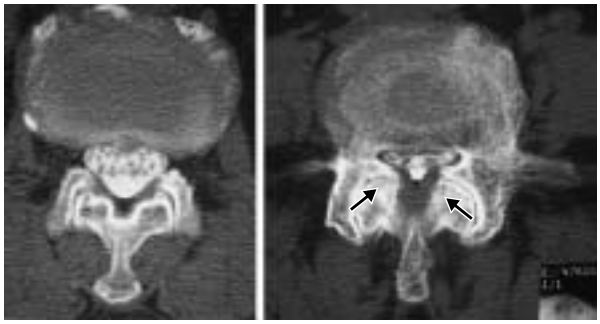

Fig. 7 A case of cauda equina-type intermittent claudication (myelography CT)
Left: At the normal level, no stenosis of the dural canal is noted.
Right: At the L4/5 level, the dural canal is compressed, due to deformity of an apophyseal joint and thickening of the yellow ligament.

2) In cauda equina-type intermittent claudication, the entire cauda equina becomes constricted, resulting in a multi-root disorder with numbness of both legs as the chief complaint (Figs. 3, 6, 7). This disease is often accompanied by perineal perception disturbance, and/or bladder and rectal disturbances — and the absence of pain is characteristic.

3) Mixed-type intermittent claudication has a clinical picture including both the nerve root and the cauda equina types.

Objective Findings

Generally, there are few objective findings compared with the subjective symptoms. In the nerve root-type disorder, nerve root irritation symptoms and nerve deficiency symptoms, such as perception disturbances, weakened muscle strength, and decreased lower limb deep tendon reflexes, are noted, as with herniation of a lumbar disk, which can be helpful in diagnosing the segment.

In cauda equina-type disorder, the Achilles tendon reflex is usually lost bilaterally, even at rest. Even if the reflex is noted at rest, Achilles tendon reflexes disappear bilaterally in a load test.

What Should Be Observed by Which Test?

1. Image test

(1) Simple X-ray examination

On the simple X-ray examination (front and lateral views), observation should be made of the alignment of the lumbar spine and destructive changes (hypertrophic changes of the vertebral arches and apophyseal joints, spur formation of the posterior margin of the vertebral body, narrowing of the intervertebral spaces, shortening of the interpediculate distance, narrowing of the intervertebral formen, etc.).

(2) MRI examination

On MRI examination with T_1-weighted images the condition of the yellow ligament and peridural fat tissues are observed, and with T_2-enhanced images, the range and degree of compression of the dural canal can be observed, because the cerebral spinal fluid shows a high intensity. However, bony tissues show low intensity, so CT is superior for observation of osseous lesions.

(3) Myelographic examination

Since myelography is a slightly invasive

Table 2 Operative Treatment of Lumbar Spinal Canal Stenosis

Nerve root type	Decompression of responsible nerve roots is conducted by wide fenestration surgery. For this, it is necessary to confirm the responsible nerve roots by nerve root block before surgery. The effect of the treatment is apparent immediately after the operation.
Cauda equina type	Most cases do not respond to conservative treatment. Decompression of the entire dural canal is conducted by extensive laminectomy and spinal canal extended operation.
Mixed type	Decompression of the dural canal (cauda equina) and nerve roots is conducted.

examination, it is now only used as a supportive means in the case of clinical pictures that are difficult to judge by MRI and CT, unlike in the past.

Compared with MRI, this examination is useful for observing the dynamic factors that compress the cauda equina and nerve roots when the lumbar spine is bent forward and backward. It is suitable for observing the hourglass patterned compression image of the dural canal, complete block, the cystic image of nerve root deficiency, redundant nerves, and arachnitis.

2. Selective nerve root block

Selective nerve root block is useful for specifying which vertebra is really responsible, even when many vertebrae seem to be narrowed, to secure the efficacy of the operation.

Treatment—What Kind of Choices Are Available?

Treatment varies depending on the type of stenosis. As a general treatment policy, conservative treatment is usually effective and is therefore the first choice for the nerve root type. On the other hand, for the cauda equina type, there is not a tendency of spontaneous remission. Therefore, for the cauda equina- and mixed types, the patients are first given conservative treatment for a while, and if it is shown to be ineffective, surgical treatment may be selected, after the patient understands fully.

1. Conservative treatment

With drug treatment, anti-inflammatory analgesics are first administered to reduce local inflammation and pain. Then, from the viewpoint of blood flow improvement, recovery, and promotion of affected nerve tissue regeneration, drugs that improve blood flow and vitamin preparations are administered.

Block treatment includes epidural block, caudal block, and nerve root block, and it is used for severe low back pain and leg pain.

Orthosis treatment aims to support and reinforce the spinal dorsolumbar musculature, which weakens with aging, decrease the forward curving of the lumbar spine and increase the abdominal pressure. A simple corset and a Williams orthosis (canvas corset) can be used for several months.

Exercise treatment includes various exercises that increase the dorsolumbar muscle strength.

2. Surgical treatment

When symptoms do not improve on various conservative therapies, surgical treatment is considered. The purpose of surgery is to conduct full decompression of the cauda equina and the nerve roots, while minimizing architectural destruction of the spine. However, limited decompression is sometimes insufficient, and restenosis can occur. On the other hand, extensive decompression can cause instability after surgery, through architectural weakening of the spine.

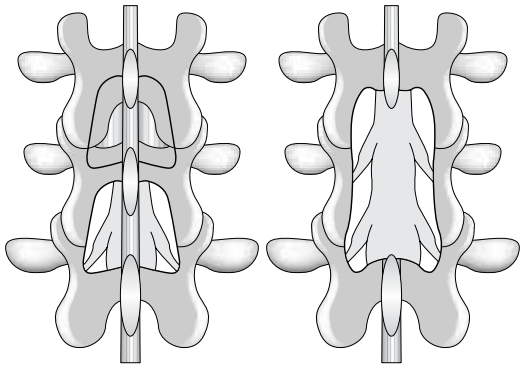

Fig. 8 Representative operative treatment
Left: Wide fenestration surgery
Right: Extensive laminectomy

Specifically, according to the condition of each case, decompression of the pressed dural canal and nerve roots is conducted (Table 2), through posterior wide fenestration surgery (Fig. 8, left) and extensive laminectomy (Fig. 8, right). When vertebral instability (slipping) is also present, spinal fusion is also considered.

If the sensation of warmth is restored to previously numb soles immediately after surgery, the efficacy of the operation is judged to be very good. Intermittent claudication will quickly disappear. However, symptoms that used to be present at rest, especially numbness of the soles, and bladder and rectal disturbances, due to cauda equina-type disorder, take time to recover. The existence of neurological symptoms even at rest before surgery, regardless of the neurological disorder types, indicates that advanced stenosis had been present for many years. In such a case, the cauda equina nerve is relaxed or tortuous (root redundancy), and mild adhesive arachnoiditis occurs. As such, even with surgery, the symptoms may not necessarily be alleviated, and symptoms may relapse several years later.

Conclusion

The diagnosis of lumbar spinal canal stenosis is mainly based on the patient's subjective symptoms, which are not present at rest, but appear mostly in a standing position and when walking. This disease is therefore sometimes not easily understood by the people around the patient. In many cases, patients and their families stop treatment, considering the symptoms to be simple neuralgia due to aging. Therefore, the pathology of this disease should be explained well to gain the understanding not only of the patients, but also their families. It is not true that the patients will be paralyzed, or that they will be forced to use a wheelchair, if this disease remains untreated. At the time point that symptoms do not improve with adequate conservative therapy, operative treatment should be considered. Today, as more old people want to maintain an active life, lumbar spinal canal stenosis is one of the diseases for which treatment opportunities will increase.

Low Back Pain Accompanying Osteoporosis

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Toshitaka NAKAMURA

Professor, Department of Orthopedic Surgery,
University of Occupational and Environmental Health

Abstract: In osteoporosis, the vertebral body deforms through fracture, causing low back pain at various levels. Osteoporosis with marked acute low back pain is rather infrequent, and in many cases, vertebral body deformation and loss of body height progress with almost no low back pain. Some cases without fracture complain of indefinite pain and a sense of discomfort in the lumbar area, due to hypersensitivity to pain, which is a symptom peculiar to menopause. In the acute phase of low back pain in osteoporosis, pain is alleviated using anti-inflammatory analgesics, etc. For pain in the chronic phase in cases with spine deformity and/or dorsal kyphosis, therapeutic heating of and physical therapy for erector spinae muscles are also effective. The load to the vertebral body significantly changes depending on daily living activities, so the patients should be instructed to engage in activities with good muscular balance. Bisphosphonates, such as alendronate, can reduce the incidence of vertebral factures in osteoporosis to about half, and they are also effective in preventing body height decrease and dorsal kyphosis. It is necessary to conduct appropriate pain control in respective phases, and to administer therapy to prevent fractures in osteoporosis, in order to prevent spine deformity and height decrease due to new fractures, even after the pain disappears.

Key words: Vertebral body deformation; Body height decrease; Hypersensitivity to pain; Daily living activities; Bisphosphonate

Introduction

Osteoporosis is a condition in which bone mass decreases, causing abnormality in structure, and reducing bone strength, resulting in an increased risk of fracture. Even when bone mass is decreased and abnormality occurs in its structure, no symptoms are usually caused. In

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osteoporosis, clinical symptoms become clear only after a fracture occurs. However, clinical symptoms of a fracture caused by osteoporosis are considerably different from those of a normal fracture, which is caused by great external force imposed on a normal bone. Therefore, a fracture caused by great external force is called a traumatic fracture, and a fracture in osteoporosis is called a fragility fracture, to differentiate between the two.

Low Back Pain in Osteoporosis

A fragility fracture occurs when weakened bone is destroyed due to an external force that exceeds the strength of the bone. External force that causes a fragility fracture ranges widely, from a light force caused in daily living activities, to a strong force, as in a normal traumatic fracture. Therefore, a fracture in osteoporosis can be accompanied by acute severe pain, in some cases, and by almost no pain, in some mild cases, depending on the severity of vertebral body collapse.

1. Acute low back pain and clinical fracture of the vertebral body

Fracture in osteoporosis with acute low back pain can be categorized into the type accompanied by rapid deformation, and the type accompanied by gradually progressive deformation. In either type, when vertebral body tissues are destroyed, sharp pain in the low and upper back occurs. Some patients with strong pain cannot even roll over, but many become better after rest in bed for a few weeks. In the acute phase, deformity of the vertebral body is not clear on X rays in some cases. Vague dull pain sometimes continues in the entire low and upper back, after acute pain disappears. For a few months after occurrence of pain, deformation of the vertebral body tends to accelerate.

If sharp pain intensifies over time, other causes, such as metastasis, should be considered. MRI and urinary concentrations of cross-linked N-telopeptides of Type I collagen (NTx), a marker of bone metabolism, etc., have been helpful in diagnosing bone metastasis from a malignant tumor. A fracture with rapid deformation of the vertebral body accompanied by acute pain is called a clinical fracture.[1)]

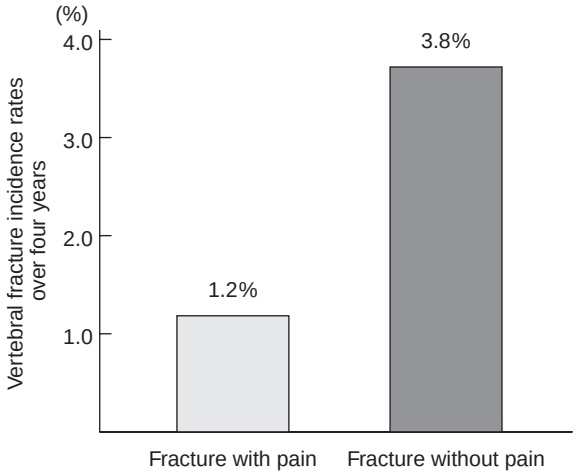

Fig. 1 Pain of vertebral fracture due to osteoporosis
Four-year research on 4,432 osteoporosis cases without fractures in the West. There were three times more cases without pain and with fracture deformity found on X rays, compared with cases with vertebral fracture with pain.
(Cited from Cummings, S.R. *et al.*: Effect of alendronate on risk of fracture in women with low bone density but without vertebral fractures: Results from the Fracture Intervention Trial, *JAMA* 1998; 280: 2077–2082)

2. Chronic low back pain, and vertebral fracture mildly progressing without symptoms

Not every vertebral fracture due to osteoporosis is accompanied by sharp pain. Some cases start with chronic back pain, and have gradually progressing dorsal kyphosis, together with vertebral deformation. Also, in some cases, pressure deformation of vertebral body progresses with almost no low or upper back pain. A U.S. study, in which X rays of the thoracic spine and lumbar spine were taken over three years, on about 7,000 patients with postmenopausal osteoporosis, of about age 65, on average, found an increase of pressure fractures every year in about 1.5% of the subjects.[1)] Among them, about 1/3 felt acute pain; the remaining cases had no clear pain (Fig. 1).[2)]

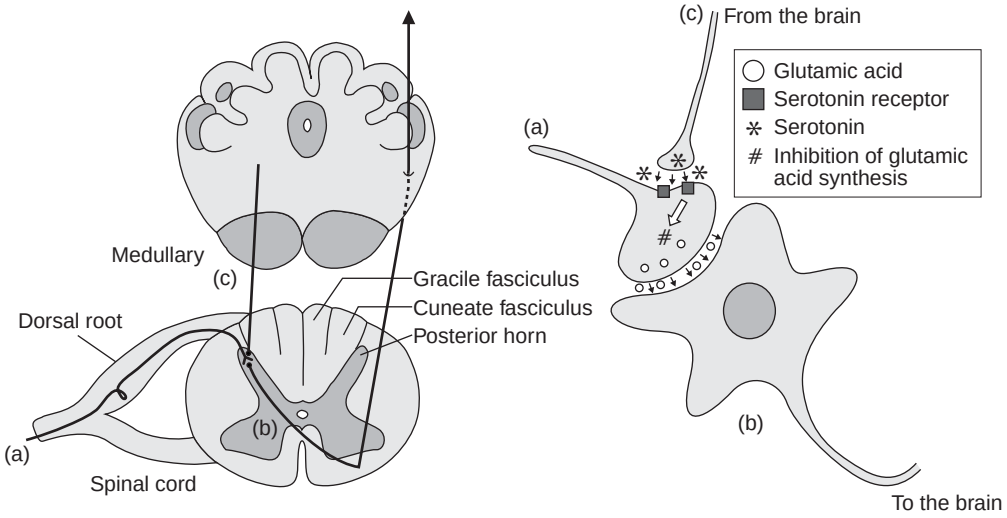

Fig. 2 Conduction route of pain in the spinal cord
(a): Sensory nerve, (b): Conduction route of pain to the brain, (c): Nerve to inhibit conduction of pain descending from the brain. The nerve that inhibits pain from the brain inhibits synthesis of glutamic acid in the sensory nerve, by secreting serotonin. Therefore, pain is alleviated and less pain is transmitted to the brain. When female hormones become reduced, this inhibitory effect is lowered, resulting in hypersensitivity to pain.

A larger number of cases with osteoporosis have only progression of pressure deformation of vertebral body, without acute low or upper back pain, compared with cases with acute pain, which is clinically important. When the spine is being bent, or the height is decreasing, even without pain, it is necessary to consider the possibility of vertebral fracture due to osteoporosis. As such, existence of vertebral fracture without pain (morphometrical fracture), which occurs in the chronic course, has been clarified, and fracture judged only based on X rays has been called morphometrical fracture.[3] It is necessary to recognize that there are two types of vertebral fractures due to osteoporosis: morphometrical fracture and clinical fracture.

3. Hypersensitivity to pain and low back pain in postmenopausal women

Even cases without vertebral fracture in postmenopausal osteoporosis sometimes complain of indefinite pain and discomfort in the low and/or upper back. The sensation is sometimes expressed as "like an insect moving around on my back" and "tingling like an ant crawling." Chronic low and/or upper back pain due to osteoporosis includes such sensation, which is considered as a type of hypersensitivity to pain, which is a symptom peculiar to menopause.

Transmission of C-fibers of a sensory nerve is inhibitorily adjusted by the nerve fiber descending from the brain in the spinal cord (Fig. 2). The transmitter of this nerve is serotonin, and the terminals of C-fibers have serotonin receptors.

In a rat experiment, estrogen deficiency caused by ovarian resection results in decreased serotonin receptors at the terminals of C-fibers, and an increase of transmissibility of pain stimulus. It has been clarified that administration of calcitonin restores the number of serotonin receptors, and hypersensitivity to pain disappears.[4] Low and/or upper back pain in postmenopausal osteoporosis can be related to not only bone but also a central effect of estrogen deficiency.

Dorsal Kyphosis and Body Height Decrease in Osteoporosis

Many postmenopausal women have a rounder back and shorter height as they get older. The deformity and shortening of the backbone in the elderly are caused by two main factors. One is decreased thickness of the interspinal disks, and the other is vertebral fractures. In osteoporosis, the back becomes bent and the body height decreases due to vertebral fractures. Studies in the West clarified that body height decreases by about 1 cm per year due to vertebral fractures in women with postmenopausal osteoporosis in their 60s and 70s.[5] Vertebral fractures due to osteoporosis are a major cause of bending of the back (dorsal kyphosis) and height decrease in the elderly.

Risk of vertebral fractures in osteoporosis varies greatly depending on the presence or absence of existing vertebral fractures. According to data on Western osteoporosis patients, of ages 60 to 75, cases that have never had a vertebral fracture, experience their first vertebral fracture at a yearly incidence of about 1 to 3%; cases with a vertebral fracture have a new vertebral fracture at a yearly incidence of 11.5%, and the incidence of cases with two or more vertebral fractures reaches 24.0%.[5]

The incidence of vertebral factures in Japanese, which is slightly higher than that in Western people, is about 5 to 7% in osteoporosis patients, in their 60s, without vertebral fracture, and about 12 to 14% in cases with one or more vertebral fractures.

An important point here is that, in both Western and Japanese people, the incidence of occurrence of new vertebral fractures due to osteoporosis increases as the number of existing vertebral fractures increases. Once a vertebral fracture occurs, there is a higher risk that many vertebral fractures will occur in the following several years, resulting in back bending. To prevent dorsal kyphosis and chronic back pain due to osteoporosis, therefore, it is important to prevent occurrence of the first vertebral fracture.

Management of Low Back Pain in Osteoporosis

As to diagnosis by X rays in cases with deformity of the spine, osteoporosis is diagnosed if vertebral deformity (wedge vertebra, fish vertebra, vertebra plana, etc.) caused by a pressure fracture is found, while osteoarthritis of the spine is diagnosed if degenerative changes of the spine are observed. If both conditions are noted, both diagnoses are made, in some cases. The cause of low back pain in such cases is dorsal kyphosis, and the measures for low back pain are the same. If a pressure fracture due to osteoporosis exists, treatment should be conducted to prevent a new fracture.

1. Acute low back pain

For acute low back pain due to a vertebral fracture, bed rest is important, above all. The pain always improves. Both anti-inflammatory analgesics and calcitonin injection are effective to ease pain. In cases with subacutely progressing vertebral deformation, after occurrence of vertebral fractures, a light trunk orthosis, such as a corset, is effective. For hypersensitivity to pain in postmenopausal women, calcitonin, etc., are effective.

2. Chronic low back pain

When there is a dorsal kyphosis and the lumbar part is anteflexed, low back pain originates from the intervertebral joints, and from bone, cartilage, and ligament tissues surrounding the interspinal disks, as well as from muscle tissues and fascia that support the spine. Pain from muscle tissues and fascia can be fatigue-induced pain or ischemic pain. Muscle strength lowers according to aging and lack of exercise. When the erector spinae muscles at the back side of the vertebral body decline, muscles easily become overworked, causing low back pain, even from standing and walking for a short time. Especially when the lumbar spine becomes

anteflexed, the erector spinae muscles become stretched, causing constant muscle contraction to cope with the condition, resulting in chronic fatigue. Further, intramuscular pressure increases and fascia becomes tense. Intramuscular blood flow is disturbed, and ischemic pain is added. Therefore, chronic dull pain is likely to occur in cases with an anteflexed lumbar spine.

For chronic low back pain due to deformity of the spine and dorsal kyphosis, not only anti-inflammatory analgesics but also injection of local anesthetics, and such physical therapy as low-frequency therapy, and heating to the erector spinae muscles, in the low and upper back, are effective.

3. Instruction on daily living activities to prevent vertebral fractures

Healthy human bones are strong enough to endure the load from daily living activities. When one lifts something heavy, a load several times greater than the body weight is imposed on the lumbar spine, and yet the vertebral body suffers no damage.

In the action of bending the back, 200 to 300 kg of force is imposed on the vertebral body, but a normal vertebral body can stand the force of over 1,000 kg. When bone mass decreases and abnormality occurs in the structure, strength also declines. In osteoporosis, bone density and strength of the vertebral body decrease respectively to about 70% and 50% compared with a healthy person. As a result, strength of the vertebral body against the load applied to the low back in daily living activities is reduced, increasing vulnerability to fracture. From another viewpoint, however, even if bone mass decreases due to osteoporosis, the vertebral body can still endure up to 3 to 5 times the body weight.

Force imposed on the vertebral body greatly varies depending on daily living activities. Especially when a strong force is imposed on the muscles of the back, the load on the vertebral body tends to increase. The load on the vertebral body can be reduced by avoiding sudden movement in stretching or bending the low back, and in lifting something from the floor, and by trying to move gently and in a good muscular balance. To prevent a fracture due to osteoporosis, instruction on daily living activities, in addition to increasing bone strength, is necessary.

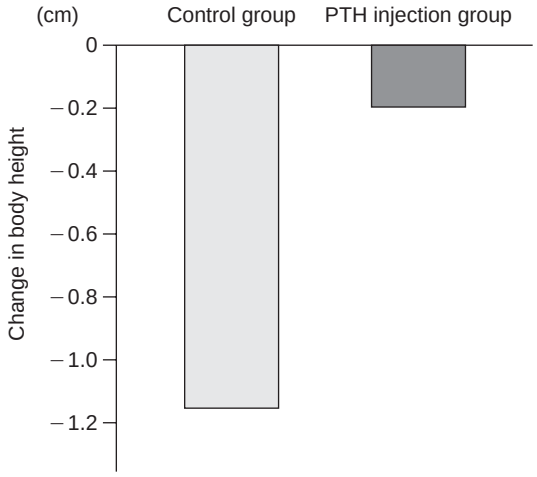

Fig. 3 Effectiveness to prevent body height decrease in osteoporosis treatment

In a large-scale study conducted in about 1,600 osteoporosis cases at age 68, on average, the body height decreased by about 1.2 cm per year in the control group. In the group in which the fracture rate lowered due to parathyroid hormone (PTH) injection, the body height decreased only by about 2 mm.

(Cited from Neer, R.M. *et al.*: Effect of parathyroid hormone (1–34) on fractures and bone mineral density in postmenopausal women with osteoporosis. *N Engl J Med* 2001; 344: 1434–1441)

4. Drug treatment to prevent vertebral fractures

Regarding vertebral fractures due to osteoporosis, it has been confirmed, in large-scale clinical trials, that adjustment of bone metabolism can lower the risk of new fractures.

For example, alendronate, which is a bisphosphonate, has an effect to inhibitorily adjust the increased bone metabolism. This drug begins to show efficacy to prevent vertebral fractures from six to 12 months after the start of treatment, and it can reduce the risk of occurrence of one or more vertebral fractures to about half, compared with a group that does not use

the drug, in four years.[1,2] Further, this drug prevented occurrence of two or more vertebral fractures by 84%, and three or more vertebral fractures by 100%.[1]

Another bisphosphonate: risedronate, also inhibited incidence of one or more vertebral fractures by about 40% in three to five years.[7] In addition, it has been clarified that raloxifene,[8] which is a female hormone receptor modifier, parathyroid hormone, etc., can assuredly inhibit risk of vertebral fractures.[5] Respective studies using alendronate, and parathyroid hormone, have clarified that body height decrease also can be prevented[1,5] (Fig. 3).

Today, risk of vertebral fractures can be certainly reduced by learning the conditions of bone mass and metabolism, and conducting drug treatment if necessary. For low back pain in osteoporosis, therapy to prevent new fractures even after symptoms disappear, in addition to symptomatic treatment, is necessary.

5. Instability of the spine due to fractures in osteoporosis

Even in fractures due to osteoporosis, the vertebral body can be severely collapsed, resulting in disturbed stability of the spine, though this is infrequent. This condition is often seen in persons of age 70 or older with the anterior wall of the vertebral body significantly collapsed and deformed into a triangle shape, or those whose central part of the vertebral body is crushed and the entire vertebral body is almost disrupted. There has been minor but apparent traumatic mechanism observed in these patients, such as a fall, immediately followed by rapid collapse of the vertebral body and pain. Subsequently, even after the acute phase, the low back does not become stable and low back pain continues. In these cases, surgical treatment is sometimes necessary to promote bone healing of the collapsed vertebral body and restore stability to the spine, so consultation should be sought with an orthopedist.

Conclusion

Low back pain due to osteoporosis is diversified, such as pain from fractures in the acute phase, and pain caused by deformation of the spine and dorsal kyphosis in the chronic phase. It is necessary to administer pain control according to respective phases, and to try to prevent bone fractures due to osteoporosis, to prevent deformation of the spine and body height decrease resulting from new fractures, even after the pain disappears.

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Measures Taken by the Government for Improving Mental Health of Children
—Through promotion of Sukoyaka Family 21—

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Kiyomichi FUJISAKI

Managing Director, Medical Cooperation Department,
Japan International Cooperation Agency (JICA)

Abstract: Problems of mental health in the field of child health are increasingly significant in the 21st Century of Japan. The measures to be taken by the Government to tackle them are all depicted as well as those taken by other concerned parties in the Sukoyaka Family 21 that has been planned and promoted by the Ministry of Health, Labor and Welfare. In fact, to solve the children's mental health problems, the roles of concerned parties such as the people (residents), public entities, professional organizations, and civilian organizations are more significant than those of the Government—although the Government plays its proper and unique parts. Sukoyaka (meaning "healthy and happy" in Japanese) Family 21 is a vision to clarify issues both pending and new, and to present major initiatives to be taken in the early 21st century (2001–2010) concerning the issue of maternal and child health based on the achievements made to date. It is also a national campaign, which is to be jointly promoted by the various parties and organizations concerned after having established certain objectives for each of the issues. Four major agenda items have been agreed and being worked on: ① Stepping up health care measures and promoting health care education for the adolescents: ② Assuring safety and comfort during pregnancy and childbirth, and supporting for infertility: ③ Maintaining and improving the standards of child health care and medical service: ④ Promoting trouble-free mental development of children and alleviating anxiety about child rearing.

Key words: Sukoyaka Family 21;
National campaign for Maternal and Child Health;
Mental health of children

Introduction

As a result of continued efforts made by concerned parties various indicators of children's health show that Japan is already at the top level globally in the 20th century.

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However, this achievement is only limited to physical health of children and their mental health is not improved comparably — rather it has even been widely recognized as a serious social problem since the late 20th century. It is cautioned that the situation will be worse if effective measures are not to be taken.

The Ministry of Health, Labor and Welfare of Japan is now tackling the issue of children's mental health with its full efforts. Sukoyaka (meaning "healthy and happy" in Japanese) Family 21, which sets out the vision for maternal and child health for the early 21st century and operates as a national campaign as well, started January 1st, 2001 and encompasses all the measures being taken by the Ministry. It is the author's view that within the sphere of maternal and child health in the 21st century we need to realize "mental health is important" rather than "mental health is important, too", and therefore it's time for us to set mental health as the central issue.

It should be noted that the aforementioned approaches must be undertaken as quickly as possible to prevent the unfavorable state from becoming even worse, although the solution can hardly be realized only by the efforts from the sector of maternal and child health since the problem of children's mental health is a reflection of the complex environments of the modern society surrounding them, including their parents' mental conditions.

This article first outlines Sukoyaka Family 21, then refers specifically to its efforts to tackling children's mental health, and finally touches upon the role of the Government or Ministry of Health, Labor and Welfare in promoting such undertakings. And refer to the full report of Sukoyaka Family 21 for further information.

What Is Sukoyaka Family 21?

• Vision and national campaign

Sukoyaka Family 21 is a vision to clarify issues both pending and new, and to present major initiatives to be taken in the early 21st century (2001–2010) concerning the issue of maternal and child health based on the achievements made to date. It is also a national campaign, which is to be jointly promoted by the various parties and organizations concerned after having established certain objectives for each of the issues (Figure). A Report on Sukoyaka Family 21 (referred as Report hereafter) was formulated on November 17, 2000 by its planning committee in Ministry of Health, Labor and Welfare and the national campaign started on January 1, 2001.

• Issues agreed for Sukoyaka Family 21

The following four major agenda items have been agreed and being worked on in the 21st century:

① Stepping up health care measures and promoting health care education for the adolescents;
② Assuring safety and comfort during pregnancy and childbirth, and supporting for infertility;
③ Maintaining and improving the standards of child health care and medical service; and
④ Promoting trouble-free mental development of children and alleviating anxiety about child rearing.

Each agenda item consists of three parts — Recognition of Problems, Direction of Initiatives and Specific Initiatives, and the Specific Initiatives constitute the central substance of the national campaign.

It should be noted, however, that issues not included in the above four agenda items are not insignificant. These major agenda items are carefully selected as the focused target of the national campaign to prevent the activities resulting in Christmas-tree type initiatives.

• Promotion measures for Sukoyaka Family 21

The national campaign incorporates unique promotion measures. Achieving every agenda item set out in Sukoyaka Family 21 requires to draw contribution from citizens as well as the organizations and parties involved in health care, medical services, welfare, education, and

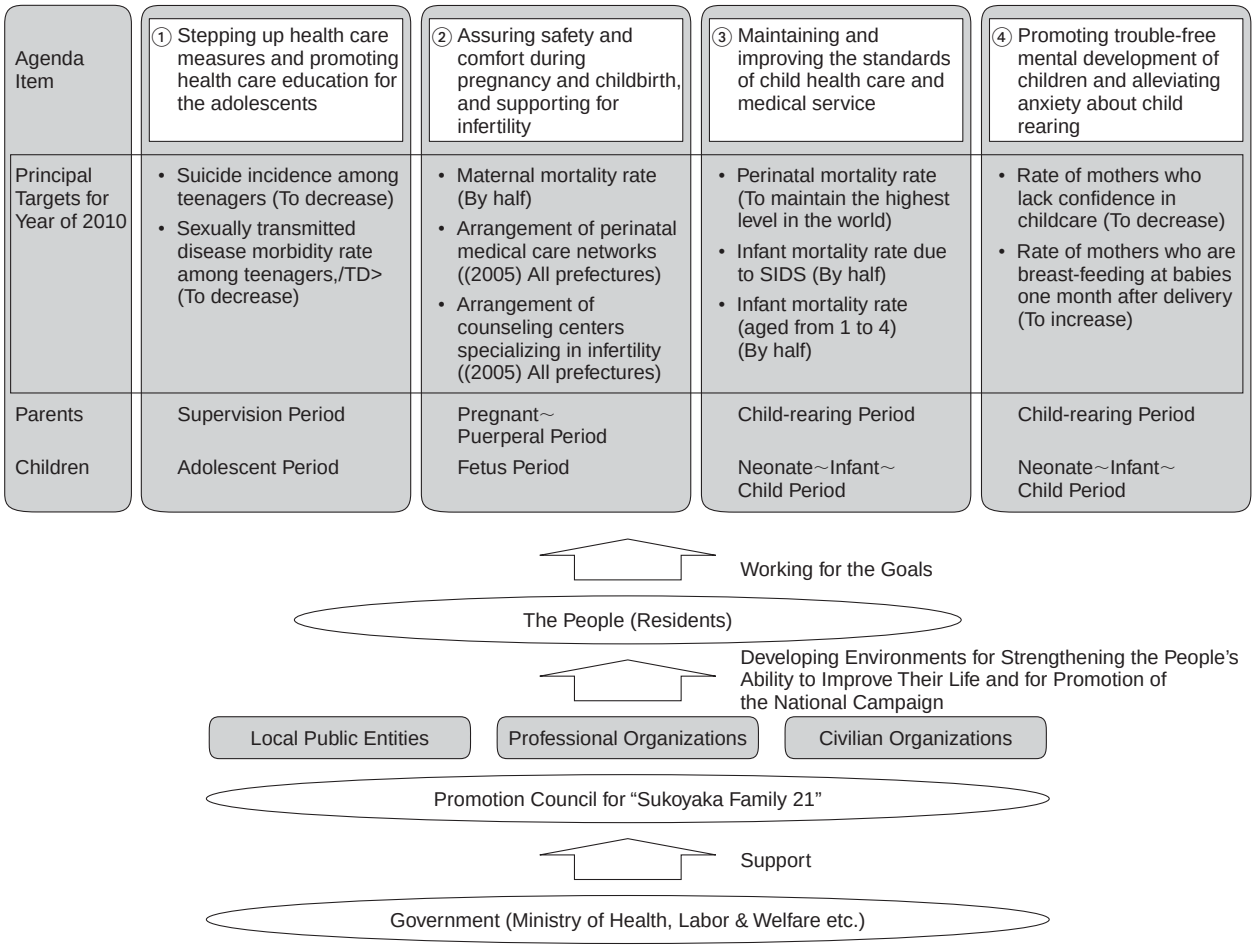

Figure National campaign for maternal and child health in the early 21st century 2001–2010

labor services from their respective positions. Therefore, the Report illustrates ways as promotion measures in which the people (residents), local public entities, the Government, professional organizations, and civilian organizations can contribute to each agenda item and sets goals by clarifying their implementation period and specific objectives to be achieved.

- **Establishment of a promotion council for Sukoyaka Family 21**

In order to effectively adjust and promote the initiatives discussed above, a Promotion Council for Sukoyaka Family 21 (Table 1) was established on April 20, 2001 at the center of this project, which amalgamates the action plans of the related parties, reports on the progress, and supervises exchanges between the related parties. The council provides information and gathers opinions via the Internet, and conduct activities to pave the way for promotion of the national campaign through national rallies. Prefectural and municipal governments are establishing similar mechanism and formulating action plans.

Sukoyaka Family 21 and Mental Health of Children

Mental health of children is one of central issues Sukoyaka family 21 is promoting. Out of four agenda items ① Stepping up health care measures and promoting health care education

Table 1 Promoting Trouble-Free Mental Development of Children and Alleviating Anxiety about Child Rearing

The people (residents)	• Make efforts to realize a society that is considerate of parents involved in child-rearing, and realize a community in which child-rearing responsibility is shared and parents are not isolated • Make efforts to create a society in which fathers can participate in child-rearing and mothers can bring up their children while working
Local public entities	• Provide systematic child-rearing support information through the use of Maternal and Child Health Handbooks, etc. • Promote measures to address child-rearing anxiety by specialized personnel (employment of child psychiatrists, midwives, counselors, etc.) • Carry out medical check-ups for parents and infants by paying attention to mental problems as part of the provision of child-rearing support • Build a care system for the high-risk population from the perinatal period through after discharge from the hospital • Develop child abuse preventive measures as part of maternal and child healthcare activities in the community • Promote activities by linking the issues of child-rearing anxiety and child abuse between municipal projects (medical check up, etc.) and prefectural projects (measures for mental health and alcoholism) • Set up a consultation window concerning child-rearing and establish a support network
The Government	• Develop screening methods that can be introduced as part of medical check-ups (child-rearing anxiety, mental problems of the child, maternity blues/postpartum psychosis) • Prepare a manual (prevention of child-abuse, early detection, and child-abuse examples as part of maternal and child healthcare) • Prepare a guide book aimed at offering support for child-rearing • Deal with mental health issues of children or mothers in the perinatal period at the National Center for Child Health and Development
Professional organizations	• Improve counseling functions so that obstetricians and pediatricians can deal with the mental issues of parents and children • Promote ties between obstetricians and pediatricians through prenatal visits • Alleviate child-rearing anxiety and provide support by encouraging pediatricians to cooperate with other institutions • Provide learning opportunities for parties involved with maternal and child healthcare (community health nurses, midwives, nurses, school health/nurse teachers, child-care specialists, teachers, etc.) concerning mental health and child abuse
Civilian organizations	• Implement community measures to avoid "isolated parents and children" • Promote child abuse prevention activities • Promote counseling for child-rearing anxiety

for the adolescents and ④ Promoting trouble-free mental development of children and alleviating anxiety about child rearing are focusing on mental health of children. This article deals only with ④ Promoting trouble-free mental development of children and alleviating anxiety about child rearing because of limited space. Citation from the Report will be indicated in double quotation marks.

1. Recognition of problems

In the first place, the issue of parent-child mental health manifesting as child abuse is described under Part 1 Recognition of Problems as follows:

"The issue of the mental health of children has been attracting widespread attention in recent years. There is a growing necessity for the health care and medical treatment sector to take necessary action, including preventive measures. It is particularly important to take up the issue of parent-child mental health as a part of the maternal and child healthcare, as it will also lead to the prevention of psychological

problems in children during adolescence. Two major problems exist in the mental health aspects of maternal and child health care; 1) the anxieties of parents about child-rearing and the relationship between parental stress and the mental state of the child, and 2) child abuse within the parent-child relationship."

"Unfortunately, however, the parties involved in community health care and medical services who are responsible for maternal and child health have not necessarily responded fully to the anxieties of pregnant women and mothers, the mental problems of the child, parent-child problems including child abuse, and support for the basis of living for parents who are in the process of child rearing.

Taking comprehensive initiatives on a national scale for the purpose of eliminating anxiety among mothers concerning pregnancy, childbirth, and child rearing, helping them enjoy child rearing without constraint but with a sense of assurance, letting them love their children, and facilitating the healthy mental development of children can be considered an extremely important measure for maternal and child healthcare for the 21st century."

In other words the above quotation stresses the significance and necessity of mobilizing all the resources and systems of maternal and child health sector, both during pregnancy and after birth, in order to improve the environments which may lead to anxiety about rearing children and child abuse. It also places an emphasis on the preventive effects on mental health problems of children. The lines point out further that since the alleviation of anxiety about rearing children can be made possible through the comprehensive community based supports, consolidation of local infrastructures for assisting child rearing, notably social welfare system, is important.

2. Direction of initiatives

The Report argues under Part 2 Direction of Initiatives that it is necessary to restructure the maternal and child health care system which has been developed for caring their physical health, into what encompasses the problems of their mental health.

"As discussed above, it is necessary to construct a care system from the standpoint of mental problems targeted at child rearing throughout pregnancy, childbirth, puerperal, and child rearing, and to watch over the growth of one human being in an optimal environment. To do this, the flow of maternal and child healthcare services in the community which starts by issuing a maternal child health handbook and the flow of the community medical services which start from medical check ups on pregnant women must be integrated, and a consistency in providing care before and after childbirth must be assured. In particular, in order to respond to the psychological problems of parents and children, healthcare and medical institutions in the community must change their routine work centered around the detection of disease and screening into one in which they are always conscious of psychological issues. In promoting such system, studies on granting subsidies for facility costs, personnel costs, operation costs, etc. as well as measures for medical treatment fees will also be necessary."

As is stated in the Report, at a community level, both medical and health service providers are required to pay attention to mental aspects of their clients in their everyday works, which is paradigm shift being necessitated. Also an adjustment of the remuneration scheme under social medical insurance system and the grant mechanism from the central government is considered necessary as prerequisite for such changes.

3. Specific initiatives

Following Part 2 Direction of Initiatives the Report mentions about concrete activities in obstetric, neonatal and pediatric medical services as well as community health services under Part 3 Specific Initiatives. It refers to pediatric medical services as follows:

"In addition to the diagnosis and treatment of diseases, pediatric departments should strive to provide care and give counseling, by observing the parent-child relationship, the psychology of mothers, the cooperative relationship between husband and wife, and the effects of these elements on the psychology and development of their child. They should strengthen ties with maternity departments through prenatal visits, and maintain close ties with child psychiatrists and health care and welfare organizations in the event of the discovery of a case requiring support from such institutions.

When we consider the situation in which a great number of children visit outpatient departments for the child, it is hard to believe that specialists (child psychiatrists, psychologists, etc.) alone can provide sufficient services. Therefore, the parties involved in pediatric health care should set up a system that can cope with problems related to child psychology."

4. Clarification of the contents of initiatives that can be taken by the respective organizations and setting goals

• Clarification of the contents of initiatives that can be taken by the respective organizations

The Report illustrates the initiatives that can be taken by concerned persons and parties in such categories and order as the people (residents), local public entities, the Government, professional organizations and civilian organizations (Table 1) regarding their daily intervention in mental health aspects through community medical and health services. Pediatricians and other medical organizations' initiatives are listed under the group of professional organizations. It should be noted that these lists are just illustrations prepared by the Planning Committee and a wider range of creative initiatives to be set forth by the concerned persons and parties is desirable.

• Setting indicators and target

The Report comes out with 16 indicators to articulate the goals for the agenda item of ④. Promoting trouble-free mental development and alleviating anxiety about child rearing (Table 2). They are made up of three levels;

① Indicators concerning healthcare standards reflect the healthcare standards of residents, including the level of QOL to be attained. They also indicate the direction that the residents and related organizations should be targeting;

② Indicators concerning residents' voluntary activities reflect the tasks to be taken up by individual residents in attaining the respective agenda items. They include indicators regarding the healthcare activities and lifestyles of parents and families and those involved with learning such as knowledge and techniques;

③ Indicators concerning the initiatives of the Government and related organizations reflect the initiatives that can be taken by them for the purpose of improving resources and the environment in such areas as project implementation, offering services and facility improvement. The indicators also function as monitoring the progress of undertakings made by professional organizations such as Japan Medical Association.

It should also be noted that the indicators were established to target the country as a whole, and therefore individual professional organizations, civilian organizations, and public entities should set their own indicators according to their respective situations.

Measures Taken by the Government

• Promotion of Sukoyaka Family 21

The way the Government tackles the issue of parent-child mental health is in accordance with the measures taken by the Government in the Report saying as follows:

"The government will strive to accumulate scientific knowledge by way of gathering necessary information and conducting surveys and research, developing health education and general education materials and holding seminars for the parties concerned. This will be intended

Table 2 Target of the Initiatives for Each Agenda Item

4. Promoting trouble-free mental development of children and alleviating anxiety about child rearing		
Index	Current status (baseline)	Target by 2010
① **[Indicators concerning healthcare standards]**		
4-1 Death toll of child abuse	[*5] (2000) 44 children	To decrease
4-2 Number of abused children who were reported to child guidance centers and others by law dealt with at child guidance centers	[*6] (2000) 17,725 cases Note: Total number of cases	To decrease via an increase
4-3 Rate of mothers who lack confidence in childcare	[*2] (2000) 27.4%	To decrease
4-4 Rate of parents who recognize they abuse children	[*2] (2000) 18.1%	To decrease
4-5 Rate of mothers who have time to spend with children in a relaxed mood	[*2] (2000) 68.0%	To increase
② **[Indicators concerning residents' voluntary activities]**		
4-6 Rate of mothers who have someone to consult with about childcare	[*2] (2000) 99.2%	To increase
4-7 Rate of fathers who participate in childcare	[*2] (2000) Participating often: 37.4% Participating sometimes: 45.4%	To increase
4-8 Rate of fathers who play with children	[*2] (2000) Playing often: 49.4% Playing sometimes: 41.4%	To increase
4-9 Rate of mothers who are breast-feeding babies at one month after delivery	[*4] (2000) 44.8%	To increase
③ **[Indicators concerning the initiatives of the Government and related organization]**		
4-10 Rate of secondary medical care areas or institutions with a system for following up high-risk infants who have been discharged from perinatal medical institutions	[*1] (2001) 85.2% Note: Ratio of public health centers	100%
4-11 Rate of those who are satisfied with infant medical examinations	[*2] (2000) 30.5% Note: Medical examinations at public health centers or health centers	To increase
4-12 Rate of self-governing bodies where infant medical examinations are conducted by emphasizing childcare support	[*1] (2001) 64.4%	100%
4-13 Rate of child consultation centers with full-time pediatric psychiatrists	[*3] (2001) 3.3%	100%
4-14 Number of institutions where short-term treatments are conducted for children with emotional disorders	[*3] (2000) 17 (15 prefectures)	All prefectures
4-15 Rate of public health centers which give support to group activities of parents who are concerned about childcare and who abuse children	[*1] (2001) 35.7%	100%
4-16 Rate of pediatricians who are skilled enough to handle mental problems of parents and children	[*7] (2001) 6.4%	100%

[*1] Health/labor science research (comprehensive studies of families and children, etc.)
[*2] Survey on the Degrees of Infant Health
[*3] Investigated by Ministry of Health, Labor and Welfare
[*4] Infant physical development survey
[*5] Investigated by the National Police Agency
[*6] Social welfare administration report
[*7] Investigated by The Japan Pediatric Association

to help the people (residents) to jointly tackle each agenda item as a community issue, and to help local public entities and the related organizations to provide active support for such activities. In addition, the government will present goals and direction, deal with public education/PR/information supply activities, as well as with the improvement of various sys-

tems and foundations, and encourage active participation of related organizations, so as to develop Sukoyaka Family 21 as a national campaign."

• Specific Initiatives

The measures the Government take to tackle parent-child mental health problem are two-holds. Those directly cope with the mental aspects are listed in a table showing concerned groups' measures under Table 1.

On the other hand, there are Government's measures dealing indirectly with the mental issue. These include supporting the formation of an attachment between mother and child through establishing a support system such as sharing of the room by mother and newborn, and the use of residential style delivery facilities under the agenda item ② Assuring safety and comfort during pregnancy and childbirth, and supporting for fertility, and maintaining and improving pediatric medical services system through raising medical remuneration for pediatric medical services under the agenda item ③ Maintaining and improving the standards of child health care and medical service. Such indirect measures for parent-child mental health have a wide and profound impact on child mental health.

Furthermore, other Government's effort such as New Angel Plan also contributes to the betterment of child mental health through alleviating anxiety about and stress of child-rearing by means of increased support for child-rearing as part of the strategy against Japan's declining birth rate.

• Role of concerned parties more significant

The measures taken by the Government for child mental health, as described above, show that they do not constitute a major portion within a set of overall measures taken by related groups. The roles of other four concerned parties such as the people (residents), public entities, professional organizations, and civilian organizations are more significant than that of Government, and which represents the very essence of Sukoyaka Family 21.

In other words, there is reality that many issues and problems of maternal and child health exist that cannot be solved solely by enforcing uniform measures nationwide with the Government's subsidy. And, therefore, the national campaign promoted by concerned persons and parties together became necessary and clarifying the measures to be taken by them and depending on their voluntary participation became the uniqueness of its promotion measures.

Conclusion

This article discussed how the Government tackles with mental health of children by introducing Sukoyaka Family 21. The conclusion is that the roles of concerned parties such as the people (residents), public entities, professional organizations, and civilian organizations are more significant than those of the Government — although the Government plays its proper and unique parts.

All the measures taken in Sukoyaka Family 21 should not terminate in a short period of time but be persistent and built into daily activities and services offered by all the concerned. The author really wishes the Japan Medical Association and others in the medical community to work together for the promotion of Sukoyaka Family 21 until the year 2010.

Indications and Limits of Digital Replantation

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Mitsuo YOSHIMURA

Director, Yoshimura Orthopedic Surgery Clinic

Abstract: Replantation should be the prime indications for treatment of amputated fingers, due to functional and aesthetic advantages. Among all cases of finger amputations, the thumb and children's fingers are the most appropriate indications for replantation, since fingers are replanted with more necessity even when conditions are not favorable in these cases. With respect to the levels at which fingers were amputated, indications have been conventionally limited to the proximal level. However, indications have been expanded to include even the level at the nails, and when there is a request from the patient, replantation is attempted even for a single finger amputation, regardless of the amputated level. Replantation was attempted for 107 digits in 85 cases during the past 10 years, and 100% replant survival was achieved. When amputation has occurred at the proximal level of the finger, functional recovery of the PIP and DIP joints are not very favorable. However, the closer the amputated level is to the tip of the finger, the less functional impairment there is in the replanted finger. When multiple fingers have been amputated, the replanted finger has generally been used as the "useful finger." Amputation of 3 or more fingers would be the best indication, in which case all fingers should be replanted. With respect to the type of injury, sharp amputation is a good indication, while blunt amputations are less likely to be regarded as indications for replantation. If amputated fingers are chilled, replantation can be attempted even after 24 hours have passed.

Key words: Digital replantation; Microsurgery; Hand surgery; Digital amputation

Introduction

Finger loss can be a significant impairment functionally as well as aesthetically. Hence, replantation should be the prime indications for treatment of amputated fingers. However,

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not all amputated fingers are the indication of replantation, since indications are determined by many factors, such as patients' request, type of finger, level of amputation, condition of injury, treatment period, and functional prognosis. Indications may also vary, depending on the skills of surgeons and hospital facilities.

Indications and Limits of Digital Replantation

Digital replantation has been conventionally indicated for fingers that have been amputated at levels proximal to the midsection of the middle phalanx, based on the notion that functional impairment of the finger will not be severe so long as the finger is preserved up to the midsection of the middle phalanx. However, indications have been expanded, and replantation is attempted regardless of the amputated level when there is a request from the patient.

1. Indication based on the type of finger

The best indication of replantation is first of all, the amputated thumb, among all fingers, since the thumb is functionally the most important digit and good use of the replanted thumb is being made regardless of the range of mobility and recovery of sensation. In order to have a more functionable thumb, a length as close to normal is equally as necessary as sensation and mobility. Therefore, replantation of the thumb should be attempted even under unfavorable conditions (Table 1).[1–3] In children, replantation is indicated for all fingers because they have a unique capacity for regeneration, the function of the replanted finger recovers well, continued growth of the finger can be expected, and also because it is aesthetically important.[4] When multiple fingers, including the thumb, have been amputated, the thumb is replanted first, followed by the opposing finger, so that to pinch and grip functions can be regained. In addition, amputation of a single finger is also an indication if the patient has a career in which hands are seen by people all the time or if the patient is a young woman.

Table 1 Indications of Digital Replantation

1.	Most favorable indications
	Amputation of the thumb at a location proximal to the IP joint
	Amputation of 3 or more fingers
	Children
2.	Relatively favorable indications
	Amputation of the thumb at a location distal to the IP joint
	Amputation of 2 fingers
	Women
3.	No indications
	Fingers that would become significantly shortened

2. Indications based on amputated site

While replantation has conventionally been indicated for amputation at the proximal portion of the finger, recovery of the functions has not been very favorable. On the other hand, the closer the amputated level is to the tip of the finger, the less functional impairment there is in the replanted finger. Therefore, replantation of the distal portion has recently become more popular.[5,6] As techniques of angiostomy have improved, some medical institutions have started to achieve high success rates even for replantation at areas distal to the DIP (distal interphalangeal) joints.

3. Indications based on the number of fingers

Based on the number of digits amputated, multiple amputations of 3 or more digits would be the best indication. When 3 or more digits have been amputated, the greatest of efforts should be devoted towards reattachment of all digits because each individual replanted digit may have some impairment of function and it would therefore make a large difference to have even one extra finger.[2] On the other hand, however, when return to work, usage, and long duration of treatment are taken into consideration, amputation of a single finger in

the case of a laborer is rarely regarded to be an indication of replantation. Since nerve repair is also essential for recovery of sensation, it is also unlikely that replantation would be indicated for treatment of a single finger amputated at the base and without any chances of nerve repair.

4. Indications based on the degree of injury

With respect to the type of injury, clean cut amputation is a good indication, while blunt amputations are less likely to be regarded as indications for replantation. Although favorable recovery of the functions of a replanted finger is hard to expect to start with, severe shortening or repair by tissue transplantation becomes necessary and the survival rate drops with crush or blunt amputations. As there is at present a limitation in the extent of functional recovery, it is necessary to make a definite decision as to whether emphasis is to be placed on function or cosmetic appearance. If the request for the procedure is strong, the author generally attempts replantation even when tissue damage seems to be severe and replantation appears difficult. Ring injuries can also have severe tissue damage, which may require tissue repair by transplantation and thus make replantation difficult. Although functional recovery is not favorable even when replant survives, there are usually strong requests for replantation because this is a common injury among women.

5. Preservation of amputated fingers and temporal limits

Muscular tissue begins to degenerate approximately 5 hours from the time blood supply has been cut off, and if major amputations are replanted past this point, replantation toxemia may occur. However, degeneration caused by loss of blood supply progresses relatively slowly in fingers that do not include any muscular tissue, making it possible for the finger to survive even when replanted many hours after the injury. The author had experienced about 10 cases of amputated fingers that had been without blood supply for 15 hours or longer, and fingers in all of these cases had survived successfully. After that, the author has seen the cases of finger amputations for these ten years. Hence, it seems reasonable to attempt replantation even after 24 hours has passed since injury as long as the fingers were chilled.

6. Indications viewed from the perspective of functional prognosis

Although it would naturally be ideal if injured fingers could be repaired so that they can be used for daily activity, in reality, this is rather difficult. As mentioned earlier, the best indications of replantation based on the functional recovery of the replanted finger, as well as usage, would be amputation at levels proximal to the IP (interphalangeal) joint of the thumb, amputation of 3 or more fingers at levels proximal to the midsection of the middle phalanx, and amputation in children in whom continued growth of the finger can be expected.[1,2,7] Since nerve repair is also essential for recovery of sensation, it is also unlikely that replantation would be indicated for treatment of a single finger amputated at the base and without any chances of nerve repair.

Preservation of Amputated Fingers and Procedure of the Stump

Preserving the amputated finger to keep it from degeneration is important if replantation is to be successful. First, the amputated portion should be wrapped in a sheet of gauze, and placed in a plastic bag. The bag should be sealed tightly so that water cannot enter, and chilled in ice water that is approximately 4 °C. Dry ice can cause the amputated finger to freeze, and even normal ice can cause it to be chilled below 0 °C if the ice is contacting the finger.

The stump of a forearm or a finger should be covered with gauze. It is easy to stop hemorrhage by simply using compression bandage

Table 2 Anesthesia in Digital Replantation (since the opening of the clinic in October 1990)

Brachial plexus block	64 cases	86 fingers
Ulnar nerve block	7	7
Low median nerve block	6	6
High median nerve block	3	3
Ulnar nerve + Low median nerve block	1	1
General anesthesia (all children)	4	4
Total	85 cases	107 fingers

and raising the patient's arm. Vessels should not be ligated or grabbed with Kocher's forceps or the like, as they can cause problems for subsequent angiostomy. The use of tourniquet should also be avoided as much as possible to prevent pain and degeneration caused by loss of blood supply.

Surgery

1. Treatment of the amputated finger

The site of injury should be disinfected and scrubbed with a brush during the golden hour, the period up to 5 hours since the time of injury, so infection can be prevented. Then, débridement and identification of tissue should be conducted under a microscope, and vessels and nerves can be occasionally marked with nylon suture. In many instances, additional skin incisions are made in the midlateral on both sides of the amputated finger to further identify each tissue. These incisions should be as short as possible and no more than 1 cm so that veins will not be injured. To what extent to shorten the bones will be determined based on the degrees to which vessels, nerves, tendons, and skin are injured. The amputated finger is then wrapped back into gauze soaked in physiological saline solution, and chilled in a container with ice water until replantation.

2. Anesthesia

The author uses brachial plexus block and axillary nerve block for replantation, and general anesthesia for children (Table 2). Surgery is also very possible when anesthesia of a single nerve is conducted at the extremity. For example, median nerve block at the wrist can be selected for amputation of the tip of the index finger or the middle finger, and ulnar nerve block can be used for the little finger. Anesthesia can last for a long surgery lasting at least 4 hours if 5 cc of bupivacain is used with 15 cc of lidocaine.

3. Perfusion in the amputated finger

Perfusion is not performed for amputated fingers, since it can cause injuries to the vascular stump or vascular endothelium and since there is no risk of replantation toxemia.

Techniques of Replantation

The author makes it a rule to repair all repairable tissues during the first surgery.[9–11)]

1. Osteosynthesis

While bones may be shortened depending on how much other soft tissues are damaged or lost, when bone shortening greater than 1 cm is required, the finger should be repaired by transplanting other tissues.

2. Tendon suture

Tendon sutures are performed in the order of extensor tendon and flexor tendon.

3. Nerve suture

Nerve suture is conducted in a bloodless area before angiostomy. Since secondary repair of nerves is difficult due to scar, nerves should be repaired primarily. Nerve transplantation is primarily conducted in a similar manner when there is a defect in the nerve. Although some have reported that recovery of sensation can be achieved without nerve suture for replantation at the tip of the finger, the author considers that nerves should be sutured to the extent that it is possible to do so, so that recovery of sensation

will be even more favorable.

4. Vascular anastomoses

The stump of the vessel will need to be resected under a microscope until normal vascular endothelium can be found. Arteries are anastomosed before veins so that blood supply to the amputated finger is performed earlier, and also so that it makes it easier to spot veins with good blood perfusion returning from the distal part. While it has conventionally been said that one artery and two veins should be anastomosed, it would be better if as many vessels as possible are anastomosed. If end-to-end anastomosis of an artery cannot be performed even when the bone has been shortened, vessels can be transplanted or transferred from other fingers. The crucial point for angiostomy is to make sure to anastomose one vessel precisely rather than to attempt to anastomose multiple vessels imprecisely, and to anastomose a thin vessel precisely rather than to attempt to anastomose a large vessel imprecisely. For this purpose, it is essential to improve one's surgical techniques. Surgeons should practice angiostomy with at least 100 vessels in animals before applying the technique to humans. Another important point is to frequently monitor the replanted fingers following surgery, and to perform another surgery as soon as possible should there be any circulation problems, such as those manifested as even a slight change of color. Survival rate may be higher in private clinics like ours in such cases, since surgeries can be performed immediately.

Indications and Limitations Based on the Amputation Site

Indications and limitations based on the amputation level of the amputated finger are explained below with reference to Tamai's classification (Fig. 1).[8)]

1. Amputation at zone V

Suture can be pretty difficult when amputation has occurred at a level proximal to the base of proximal phalanx in the case of a thumb or at a level proximal to the MP (metacarpophalangeal) joint in the case of other fingers, since vessel and nerve stumps exist in deeper areas, causing the visual field to be limited. There are cases when it is easier to perform osteosynthesis after suturing vessels and nerves. Amputation at this level is commonly seen in cases of multiple amputations, for which replantation is indicated.

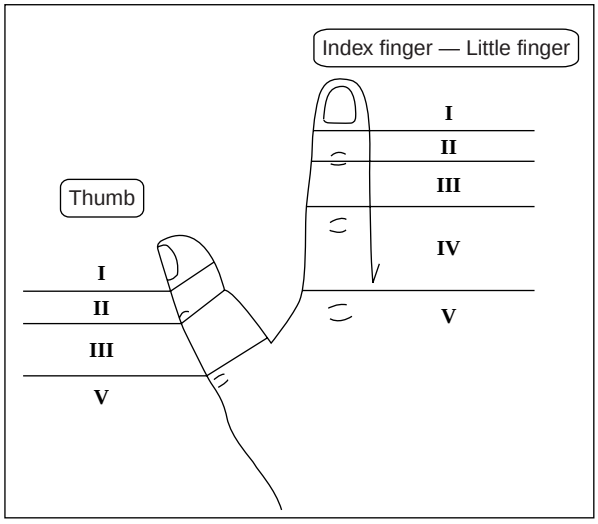

Fig. 1 Tamai's classification

2. Amputation at zone IV

This is the area, so-called "no man's land." Amputation most commonly occurs at this level. Since the recovery of motion at the DIP and PIP joints distal to the replantation site is poor, arthrodesis should be avoided to preserve as much mobility of the PIP joint as possible.

3. Amputation at zone III

Since this amputation occurs between the base of proximal phalanx and the IP joint of a thumb or between the midsection of middle phalanx and the DIP joint of other fingers, and the function of the MP and PIP joints are preserved, functional prognosis is favorable, and patient satisfaction is also generally high.

4. Amputation at zone II

Replantation at this level, between the DIP joint and the nail matrix, is very possible even though the vessels are small. Since the function of the PIP and MP joints is intact, and there would be hardly any impairment of the function, replantation at this level is being reassessed.

5. Amputation at zone I

It is functionally and aesthetically important to the finger that nails are preserved. Amputation at the nail is, therefore, also an indication of replantation.[5,6] If replantation succeeds, there will be several benefits: aesthetic excellence, preservation of the length of finger and the nail, and no need for more than one surgery. However, in some cases when replantation cannot be performed or replantation is unsuccessful, reconstruction using various types of flaps or toes may be required.[10]

Although procedures of arterial anastomosis may seem intimidating because the branch of the digital artery needs to be anastomosed at the distal where the outer diameter is no more than 0.5 mm, it is not difficult once surgical techniques are mastered. However one must be creative in performing these procedures, since the conventional vascular clip used to hold vessels are generally difficult to use in this case. An alternative to the vascular clip would be to use a single micro clip only on one side. For suture, 11-0 or 12-0 nylon suture should be used. At least one artery and one vein should be anastomosed. When veins cannot be anastomosed at all, the replant will nevertheless survive with or without the use of a clinically used leech or by continuous exsanguination through puncture. Also, even when veins to anastomose cannot be found on the day of surgery, they can often be found more easily the day after surgery, making it possible to anastomose veins.

Results and Discussion

While the survival rate for replanted digits has improved in microsurgical techniques, the survival rate varies largely from 60% to 94%, depending on the medical institution. Also, since whether or not an institution or surgeons will attempt replantation when the finger has been amputated anywhere distal to the DIP joint varies from one institution to another, such information would be essential along with the survival rate at each institution when referring a patient. In our clinic, replantation procedures have been carried out on 85 cases involving 107 digits. Classification by digit showed that thumb was involved in instances; index finger; middle finger; ring finger; and little finger (Fig. 2).

Favorable recovery of function is difficult to achieve in digital replantation, since all tissues are repaired at the same level. The present problem the surgeon faces is how good functional restoration can be achieved. There is still some limit even though functional recovery can be expected to some degree through secondary surgeries such as tenolysis. However, the Japanese tend to place as much as importance on the appearance of the hand as they do to its function and this feeling applies equally to both sexes.

Review of the state of use would be that the thumb was being used in all cases, and activity in 90% of the replanted thumb, showing how they can be useful enough even if recovery of mobility functions is poor, as long as there is enough length left in the thumb, and sensibility has recovered to a certain degree. Since growth of replanted fingers occur in children, and functions and senses improve, the author uses this procedure frequently.[4]

With respect to fingers other than the thumb, there are differences in state of use between amputation of a single finger and that of multiple fingers. When multiple fingers have been amputated, the replanted finger is used as the "useful finger" since there are no other fingers to replace it even if it is somewhat short and has a poorly recovered function. On the other hand, when only one finger has been ampu-

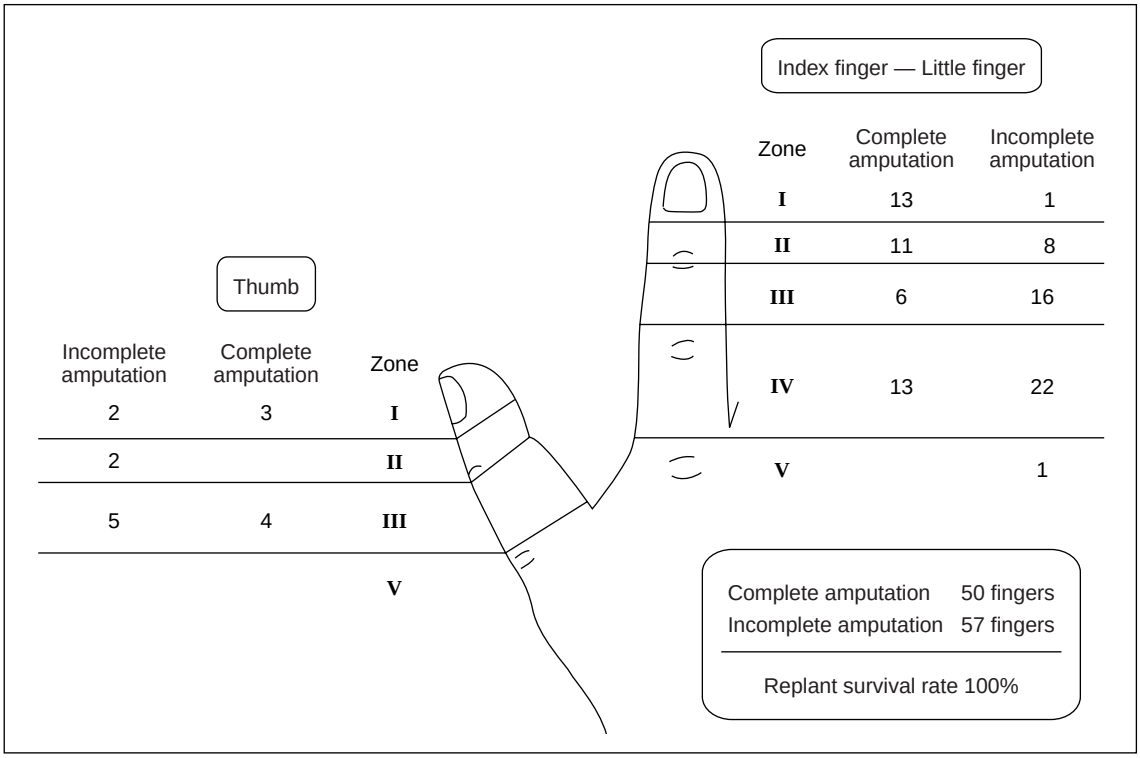

Fig. 2 Cases that underwent digital replantation (since the opening of the clinic in October 1990)

tated, the replanted finger is not used regularly unless both the sensory and motor functions are fairly favorable. Review by site of amputation showed that fingers in which replantation had been made at the distal portion were being more actively used than those reattached at the proximal portion. The finger can therefore be in the way in carrying out activities of daily living, which brings up the topic of whether or not replantation should be performed in these cases. Patient satisfaction is also high with an 85% rate of return to work.[2)]

Conclusion

Indications of replantation of amputated fingers are changing constantly. Although the functional prognosis of replantation is not very favorable at this point, our objective should be to repair the finger so that it can at least be used for daily activities. Indications of replantation may be further expanded if we endeavor to improve surgical techniques so that we will be able to meet the multifarious needs of each patient, and thereby achieve favorable recovery of functions.

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