

GAIT, LIMBS AND LIMPING

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Summary

Humans are the only true bipedals. This has several advantages e.g. having hands free for all kinds of work, but humans are also quite fit for motion. As we have only two legs it means that practically all have periods of limping if the limping is not constant for various reasons. Nearly any major problems in the musculoskeletal system, even arms, not to speak about the trunk and legs, affect the persons' gait as also the way to carry bags and other loads. Shoes are important determinants of the development of the toes and feet. Ankles, knees and hips carry the weight of the body. Overweight is one of the most common reasons for deterioration of health, often causing osteoarthritis and limping. Overweight also lessens the success in joint surgery and shortens the lifespan of prostheses. The ability to move is one of the key elements of human life, both in health and disease. When that is lost the decay of vital functions accelerates. People have danced in most cultures. In the present sedentary society its value is great in maintaining mobility, especially in the elderly.

1. Introduction

Human bipedal movement is unique and a result of sophisticated motor control systems (see *Functional Morphological and Physiological Aspects of Human Locomotion and Posture*). Standing and functioning upright requires good balancing skills and constant adaptation to changing conditions. A balanced gait and dancing requires and ensures the maintenance of healthy joint function (Figure 1). When joint loading and function gets disturbed, the body may react with pain and cause the person to alter his/her walking pattern. Limping is associated with big weight-bearing joint problems. A widely known cause for joint pain and consequently limping is osteoarthritis, a degenerative disease of cartilage.



Figure 1. Dancing. Practically all nations have traditions in dancing. It is practiced as an art form, a sport, for rehabilitation and also for pleasure. Injuries are common in professional intensive dancing but dancing as a hobby is one of the safest. Photo: Sakari Viika. "Comments" Chor. Arja Raatikainen.

Overweight and big body mass also cause extra stress on weight-bearing joints. Maintaining good lower limb strength and flexibility help to preserve functionality through to older age.

The problems of any of the components of the kinetic chain from soles to back and upper extremities and head affect motion. Healthy physiological gait is disturbed by abnormal function of any of the muscles, joints and bones and that is usually also

visually easily detected when looking at sitting, standing and walking postures. It is interesting to learn that the best 100 meter runners have very strong arm muscles and during their dash they make very efficient use of their hands to maintain speed and balance.

It is a little known fact that only one out of five people has equally long legs. In one out of five the length difference is more than one centimeter. Leg lengths can also be functionally different due to any cause of pain in the kinetic chain. The reason is self-defense to avoid pain. The muscles contract and turn the pelvis so that the spine is twisted. Problems of the kinetic chain are common. Locomotor and musculoskeletal system disturbances are the most common reasons for work absenteeism and early retirement. They are becoming increasingly common as the sedentary life style in urban life prevails and the use of cars etc. increases (see *Sedentary Life—Source of Multiple Health Problems*). Further reasons are overweight and obesity, which are rapidly increasing in many countries. They increase load on the joints and restrict normal motions, initially by simple weight but later as a consequence of problems within one or more joints.

Practically everyone experiences limping during her/his lifetime, either for short or long periods (or even constantly), and crutches may be required (Figure 2).



Figure 2. One of the most common causes of limping is pain in the lower extremities.

Simple strain and sprain injuries are part of everyday life for most people. Loading increases the pain and support from upper extremities may be needed. Crutches can therefore enable people to walk.

Adjustments of shoes can be very useful but some people also need surgical help. Fortunately joint replacements are generally very successful. Unfortunately, however, overweight and obesity may significantly shorten the lifespan of prostheses. Traffic accidents may cut away the whole or parts of a limb and it must be replaced by a long prosthesis. Unfortunately metabolic syndrome and diabetes increase the risk of ulceration of the legs due to loss of proper circulation. Smoking is an additional exacerbating factor. Amputation of toes or more of a leg may be needed to remove dead parts in order to save a patients' life, otherwise gangrene will spread. Again a prosthesis may be needed.

As problems of motility are so common and practically everyone will experience them, planners of buildings and their surroundings as well as streets, must take into account the needs of disabled people. The same is also true in esign of trains, trams, busses and planes. Such needs are even relevant to the timing of traffic lights with pedestrian pathways.

In this chapter the most common problems causing limping are discussed. As fitness of everybody is very important, the reader is urged to read other chapters in the EOLSS theme on Physiology and Maintenance.

All together, the health problems that can cause limping are diverse. They can be divided into ones that cause limping in childhood and in adulthood as are indicated in Tables 1 and 2.

<p>Bone and joint related problems Lower extremity bone fractures Childhood rheumatoid arthritis Aseptic synovitis of the hip Epiphyseolysis of the hip Bone tumors Bone and/or joint infections Osteochondrosis</p> <ul style="list-style-type: none">-Legg Calve-Perthes disease-Ostechondritis dissecans-Osgood Slatter disease-Sever's disease, Köhler's disease, Freiberg's disease <p>Overuse injuries Lower extremity deformities Lose or excessive gain of foot arches (for instance over pronation or over supination)</p> <p>Other causes General poor health that cause weakness (for instance cancer) Pain caused in association with growth Uneven lower extremity length Neurological diseases (for instance cerebral palsy, brain damage)</p>

Table 1. Examples of the childhood health problems and diseases that cause difficulties in walking and/or cause limping.

Bone and joint related problems

Bone fractures

Rheumatoid arthritis

Osteoarthritis

Bone tumors

Infections of bone and joint

Overuse fractures

Loss or excessive gain of foot arches (for instance over pronation or over supination)

Neurological diseases

Parkinson's disease

Multiple sclerosis

Amyotrophic lateral sclerosis

Paraparesis caused by spinal problems (for instance degeneration of the spine or tumors

causing spinal stenosis)

Cauda equina

Spine problems causing ischial pain/weakness/numbness in lower extremity

Cerebral blood circulation disturbances (for instance transient ischemic attack)

Brain tumors

Polyneuropathia

Polyradiculitis

Subdural hematoma

Alcoholism related organ failures (polyneuropathy and brain atrophy causing gait and

balance problems)

Other causes

General poor health and fitness preventing walking

Atherosclerosis of the lower extremities

Diabetes induced foot and leg complications (infections, ulcerations)

Muscle or neuromuscular diseases (myopathy, myositis, muscle dystrophies and neuromuscular junction diseases)

Table 2. Examples of the adulthood health problems and diseases that cause difficulties in walking and/or cause limping.

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Bibliography

Buchbinder R. (2004). Plantar fasciitis. *The New England Journal of Medicine* 350, 2159-2166. [This clinical review discusses plantar fasciitis diagnosis and treatment options and also addresses other foot problems].

Guralnik J.M., Ferruchi L., Simonsick E.M., Salive M.E. and Wallace R.B. (1995). Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *The New England Journal of Medicine* 332, 556-561. [This is a follow-up study on disability and its connection to lower limb functions, balance and walking distance].

Hamer A.J. (2004). ABC of rheumatology. Pain in the hip and knee. *BMJ* 328, 1067-1069. [This article reviews the causes of pain in the hip and the knee in children and adults].

Kettunen J.A., Kujala U.M., Kaprio J., Koskenvuo M., and Sarna S. (2001). Lower limb function among former elite male athletes. *The American Journal of Sports Medicine* 29, 2-8. [A good article on the problems of former athletes].

Kroker P. (1999). The problem of remaining upright. *BMJ* 319, 1300. [This article discusses the complexity of human bipedalism and modern trials to reproduce the human motion in technology].

National Task Force on the Prevention and Treatment of Obesity. (2000). Overweight, obesity, and health risk. *Archives of Internal Medicine* 160, 898-904. [This article assesses the current knowledge on the effects of overweight and obesity on health and reviews the public health recommendations concerning weight loss in USA].

O'Reilly S.C., Jones A., Muir K.R. and Doherty M. (1998). Quadriceps weakness in knee osteoarthritis: the effect on pain and disability. *Annals of the Rheumatic Diseases* 57, 588-594. [This article reports the results of a nested control-case study on adults aged 40-79].

Scholle H-Ch. (2005). Special Issue Pathophysiology of Back Pain. *Pathophysiology* 12 (4)231-316. [Recent overview on various aspects of trunk functions and back pain].

Shumway-Cook A. and Woollacott M.H. (1995). *Motor control: theory and practical applications*. Baltimore: Williams & Wilkins. [This book presents the scientific background and theory for practical applications of motor control].

Tsai W-L., Yang C-Y., Lin S-F. and Fang F-M. (2004). Impact of obesity on medical problems and quality of life in Taiwan. *American Journal of Epidemiology* 160(6), 557-565. [This article reports the effect of obesity on medical problems and quality of life in Taiwanese people].

Vingård E., Alfredsson L. and Malchau H. (1998) Osteoarthritis of the hip in women and its relationship to physical load from sports activities. *The American Journal of Sports Medicine* 26, 78-82. [This article assesses the effect of different levels of sport activity on the risk of osteoarthritis].

Biographical Sketches

Reetta Ronkko is a PhD candidate at the University of Kuopio, Department of Physiology. Her study area is sports medicine and current research on dancers' health and disability. She is also a third year student in medicine at the University of Helsinki. Ms. Rönkkö's previous studies have been in the areas of dance (MA in dance performance, Theatre Academy of Finland, 2002) and in kinesiology (MA, University of Utah, USA, 2001). She has been giving lectures in kinesiology and movement control both nationally and internationally and has been teaching these topics to physical therapists as well as students in physical therapy, dance and dance pedagogy.

Dr Markku Kankaanpaa, DMS was born in 1966 in Lapua, Finland. He is specialist in Physical and Rehabilitation Medicine, and currently working as a post-doc researcher in the Department of Physical and Rehabilitation Medicine, Kuopio University Hospital, Kuopio, Finland. He studied at the University of Kuopio, where he received his Licentiate of Medicine (MD) and Doctor of Medical Sciences (DMS) in 2000.

His special interests in research are lumbar disorders, especially active rehabilitation, motor control, muscle physiology, and myoelectric alterations related to low back pain and Parkinson's disease.

He has contributed 25 papers in refereed journals.

Olavi Airaksinen was born in 1955. Chairman of the Department of Physical and Rehabilitation Medicine (PRM) in Kuopio University Hospital.

Education: High school graduation in Kuopio 1974. Medical doctor from Kuopio University 1979. Specialist of Physical and Rehabilitation Medicine 1986. Academic Dissertation in University of Kuopio 1991. Associate Professor (Docent) of Physical and Rehabilitation Medicine in Kuopio University, 1993. Qualification of UEMS in PRM 1995. Qualification of UEMS on education and teaching in PRM 1997. Qualification in Pain Management 1998. Qualification for Professorship in Sports Medicine in University of Jyväskylä 2003, Chairman and Clinical Director of the Department of PRM in Kuopio University Hospital 1998-, Supervisor of education in PRM, and National Examination Referee 1993. **International Expert functions:** Member of Management Committee of COST B13 (Management of Back Pain) in EU 1999-2004 and Member of Chronic LBP working group in COST B13 in EU 2000-2004, Chairman of working group: Patient Assessment and Outcome Measures in COST B13 in EU2001-2004, Member of FIMM Science Board 2005- Member of a number Medical Associations and Vice President of Association of Physical and Rehabilitation Medicine in Finland 1995-97 and President 1997- 2000.

Referee for a number of International Journals. Publications:118 original articles (published or accepted for publication) in peer reviewed indexed International Journals, 42 other articles, two review articles in International Journals and 8 review articles in Finnish Journals, 20 chapters of books and 58 other publications and 190 communications in International Medical Congresses concerning pain management, treatment of oedema, diagnostics and treatment of low back pain, diagnostics and treatment of sports injuries and the use of surface EMG as measurement of muscle fatigue and muscular activity.