

Rehab after Knee Surgery with a rocker sole shoe (chung shi AuBioMo® shoe)

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Summary

A key skill for early rehabilitation after orthopaedic surgery is coordination. Rocker sole shoes (chung shi AuBioMo® shoes) are supposed to improve coordination. We used these shoes in a randomized controlled study in patients after partial knee replacement (UNI study) and after ACL reconstruction (ACL study). Both groups showed better results.

Introduction

After major surgery of the knee joint there is always a decrease of muscle strength, range of motion and coordination in the affected leg. These changes are especially pronounced after partial knee replacement or reconstruction of the anterior cruciate ligament. The time of rehabilitation until the full regain of the pre-surgery abilities depends on how effective strength, range of motion and coordination can be build up. For this purpose physiotherapy and Continuous passive motion (CPM) are routinely deployed. In an earlier study (Bastian, Franz) we could show that whole body vibration can significantly reduce muscle decrease after ACL reconstruction. Studies with AuBioMo shoes (Stefanyshyn, Yi) could show an increased muscle activity and an improved coordination.

UNI-Study

Purpose

Can rehab after partial knee replacement be improved by the use of rocker sole shoes (chung shi AuBioMo® shoes)?

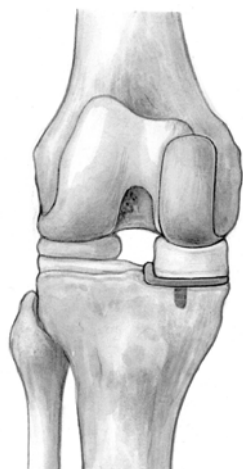
Methods

For the study with patients who underwent a partial knee replacement (UNI study) 16 patients of the Lutrina Klinik in Kaiserslautern, Germany were recruited and randomly grouped in a study and a control group. Both groups received standard postop treatment. The study group patients additionally used the AuBioMo® shoes after 6 weeks, at least for two hours per day. The subjective state and condition of the knee was assessed 6 and 12 weeks after surgery with the WOMAC score (Stucki et al.).

Partial knee replacement

Many osteoarthritis patients wear down their cartilage over the years, particularly on the inner side of the knee. At the final stage of this process, when affected individuals are so to speak 'driving on the rims', a unicompartmental knee arthroplasty (UKA) may be helpful. This implant replaces only the worn part of the joint. This spares the body's natural tissue as far as possible. Implanting a unicompartmental knee prosthesis means you also keep one trump up your sleeve if you later need to

perform a total knee arthroplasty (TKA). This means there's still enough bone material to ensure a perfect base.



Upper thigh component

Mobile meniscus insert

Lower leg component

Patients for whom a unicompartmental knee arthroplasty is suitable are becoming increasingly younger, and are fully engaged in their working lives. In other words, a unicompartmental knee arthroplasty is no longer the reserve of senior citizens. The modules for the upper and lower legs come in different sizes that can be adjusted precisely to a patient's physical characteristics. Smaller sizes are mainly used for women, for example.

The artificial knee joint largely restores mobility. Patients can bend and stretch their legs, and perform rotating movements to a certain extent. There are now implants available with the upper and lower leg heads covered in titanium, which makes them very long-lasting. This means 95% of them will easily last 15 years. The mobile meniscus part facilitates great scope for maneuver.

The unicompartmental knee arthroplasty is inserted using a minimally invasive procedure. A cut only three inches long is made next to the kneecap. Patients can start to move their leg again on the same day as the operation, and can even stand up. Owners of new joints can leave hospital after four days, and are ready to start physiotherapy.

AuBioMo® shoes

AuBioMo® means *Automatic Biomechanical correct Movement*. The sole has a 15 or 20° curve from back to front, depending on the model. A roll-preventing device is fitted in the middle of the sole, in other words, in the middle area of the foot. This tipping edge must be countered, and rolled over when walking. The multi-layered construction of the sole stabilizes and activates during forward movement. A special buffer system in the heel area provides effective protection from the initial impact of steps.

6 Rocker Construction



HINWEIS: Den Hinweis auf die Mittelfußrolle und Puffersystem in der Ferse kann man hier in die Grafik noch textlich einfügen

The AuBioMo® significantly enhances a wearer's muscular coordination and activity. The heel digs in a little deeper than usual when in standing posture. It's like running barefoot on the beach: here too, the runner's heel leaves a deep impression in the sand. The shoulders recede automatically as a result of this position. The rib cage opens up, and the entire body assumes an upright posture.

Simply standing still is no longer a passive act because numerous larger and smaller muscles are constantly active to keep the body in balance. Individuals whose jobs require them to stand up for long periods can ensure they enjoy extra exercise as a result of actively rocking from heel to forefoot.

Muscles are also challenged more than usual. Researchers at the University of Calgary have compared the work required of the leg's most important muscles in normal shoes, and in AuBioMo shoes. The result is clear: calf muscles were required to work a whole 240% harder, shinbone muscles worked 90% harder, and the vastus medialis 50% harder. The Canadian researchers took a look at the joints, and discovered the ankle joints and knee bent more than otherwise. This makes the body stand up straighter. On the other hand, the shoe reduces the burden on the knee and ankle joints while stepping and rolling off. It's clear that this is a major plus point for osteoarthritis patients.

AuBioMo® shoes improve blood circulation. The vein pumps work harder, promoting a stronger supply of blood back to the heart.

Advantages compared to other, similar shoes

with curved soles, include the fact you don't need to 'learn' how to walk with the shoes. There's less scope for making errors, inserts can be used, and the shoes can be used for walking in the country.

The manufacturer of the chung shi models is the ME & Friends AG at Holzkirchen nearby Munich. Patients taking part in the study wear models with 15° sole.

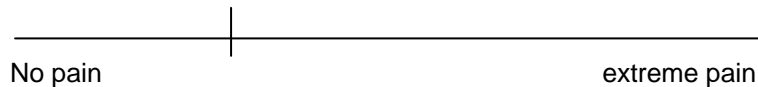
WOMAC-Score

The subjective state and condition of the knee was assessed 6 and 12 weeks after surgery with the WOMAC score (Stucki et al.). The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a valid and reliable questionnaire for patients suffering from arthritis of the knee and hip. It was developed in 1982 in Canada. The WOMAC score measures life quality of patients with osteoarthritis and arthritis of the hip. It is used in many clinical studies, translated in 65 languages und is supposed to be one of the most international accepted questionnaires.

The evaluation of the German version took place in 1996. The WOMAC score contents 24 questions in three dimensions: five questions about pain, two concerning stiffness and 17 questions about everyday activities.

We used the 100mm Visual Analogue Rating Scale format. According to his own estimation, the patient marks on a visual scale, how severe the pain is, the stiffness of the joint and the degree of difficulty at everyday activities.

Example: How to mark the amount of pain:



1. The following questions concern the amount of pain you are currently experiencing in your knees. For each situation, please enter the amount of pain you have experienced in the past 48 hours.

	None	extreme
... walking on a flat surface?	_____	_____
... going up or down stairs?	_____	_____
... at night while in bed?	_____	_____
... sitting or lying?	_____	_____
... standing upright?	_____	_____

How severe is your stiffness...

	none	extreme
... after first awakening in the morning?	_____	
...after sitting, lying or resting later in the day?	_____	

The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities, please indicate the degree of difficulty you have experienced in the last 48 hours, in your knees.

What degree of difficulty do you have with:

	none	extreme
...descending (going down) stairs?	_____	
...ascending (going up) stairs?	_____	
... rising from sitting?	_____	
... standing?	_____	
... bending to floor?	_____	
... walking on a flat surface?	_____	
... getting in/out of car?	_____	
...going shopping?	_____	
...putting on socks/stockings?	_____	
...rising from bed?	_____	
...taking off socks/stockings?	_____	
...lying in bed?	_____	
...getting in/out of bath?	_____	
...sitting?	_____	
...getting on/off toile?	_____	
...heavy domestic duties (mowing the lawn, lifting heavy grocery bags)?	_____	
...light domestic duties (such as tidying a room, dusting, cooking)?	_____	

Data

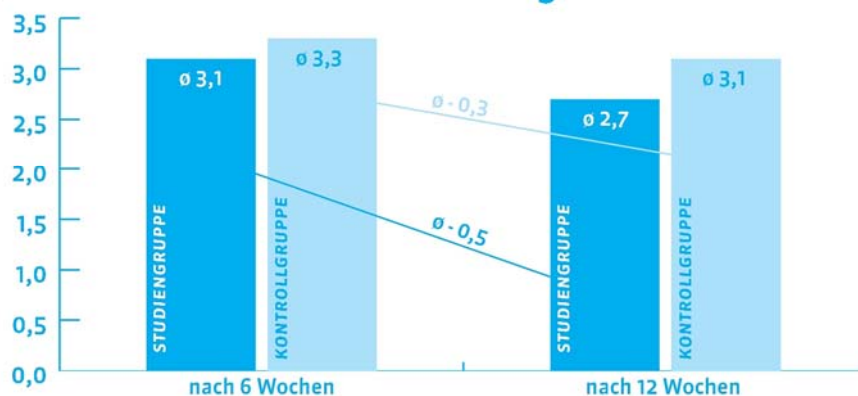
Age	sex	Body height in centimeter	weight	Study group WOMAC 12 - 6	Control group WOMAC 12-6 Wo.
67	m	167	87	37	
78	F	159	73		47
66	F	173	89		58
73	F	170	85	-12	
58	m	182	90		-11
77	F	156	76	18	
54	m	178	94		21
74	m	176	79		-47
78	m	179	96		-18
64	F	162	80	-30	
81	F	166	84		-15
67	m	180	105	-13	
75	F	160	79		12
67	m	164	83	-17	
70	F	171	86		-53
68	F	164	79	18	
69,8125		169,1875	85,3125	0,142857143	-0,66666667

Results

The average WOMAC score for the study group in the UNI study was +0,1, for the control group -0.7. The average WOMAC score for the study group in the UNI study was +0,1, for the control group -0.7. This means a clear tendency for better results in the study group, but no statistical significance.

To show a positive effect in a significant way, many more patients are needed. The surgery and the rehab-program alone put the mostly elder patients under stress. They were anxious about wearing the rocker sole shoes. As a result of the UNI study, the rocker sole shoes should be offered to patients who explicitly want to wear them, but there is no recommendation for a general use in the very early phase after knee replacement.

5 a Tables - UNI study



ACL study

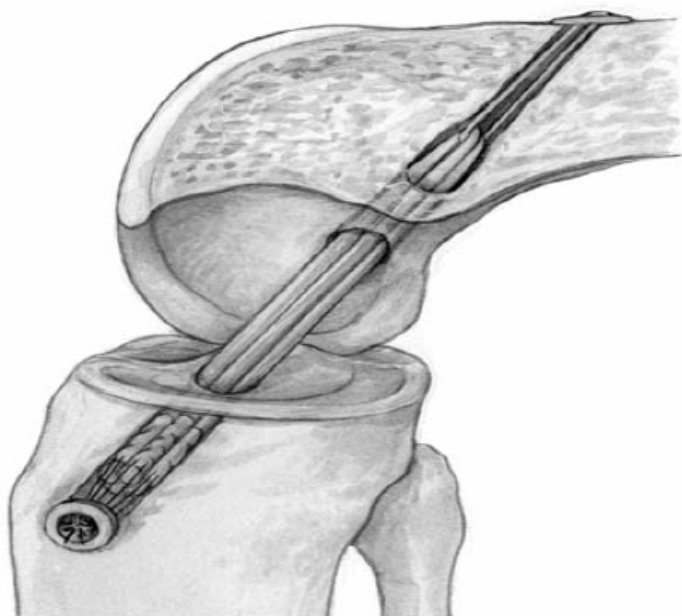
Purpose

Can rehab after ACL reconstruction be improved by the use of rocker sole shoes (chung shi AuBioMo® shoes)?

Methods

For this study with patients who underwent ACL reconstruction (ACL study) 51 patients were recruited. The study group patients used the AuBioMo® shoes 2 weeks after surgery. The assessment of coordination was done with a computerized flexible plate (Physiomat) after 6 and 12 weeks.

The ACL reconstruction



The cruciate ligaments are extremely important for the stability of the joint. A torn cruciate ligament doesn't heal on its own. Wobbly knees always result in osteoarthritis after a few years. Most injuries to the cruciate knee ligament require repair as a result. This is why even children's cruciate knee ligament injuries should be treated.

The operation can be done arthroscopically, only a small incision into the skin is needed. The torn cruciate ligament is replaced by a tendon. We developed a new technique to take the tendon nearly "invisible" from the back of the upper leg (semitendinosus tendon). Here four tendons with the same purpose are situated. So it's no problem to extract one of them. Up to now no scientific study about negative impacts is published. Many professional soccer players undergo surgery by this technique and afterwards they reach their top form again.

During the operation the tendon is inserted through bone channels into the shin and thigh bone and positioned at the place of the intact cruciate ligament. The grafted tendon is attached in such a way that the patient can move or put weight on the knee immediately after the operation. The tendon requires approximately six weeks to heal into the bone. The patient has to stay in the hospital for 3 – 4 days.

The latest technology to reconstruct a torn anterior ligament is called "Double Bundle". It's a very challenging method for skilled surgeons. "Double Bundle" was developed in the USA and by Heinz-Jürgen Eichhorn, M.D. from Straubing near Munich, who was the first to use it in Europe. Instead of using only one new tendon to replace the cruciate ligament, the new technique is built on the use of two tendons between the shin and thigh bone. The advantage: The two tendons, which are fixed at different places, bring more stability to the joint. They prevent a sudden giving-away of the knee.

The state-of-the-art technology is called "All-Inside", no more bone channels are drilled from the outside. This reduces pain and requires less healing time.

The patient should use crutches for about a week in order to take weight off the operated leg. Thereafter, the patient is permitted to put full weight on the leg. From

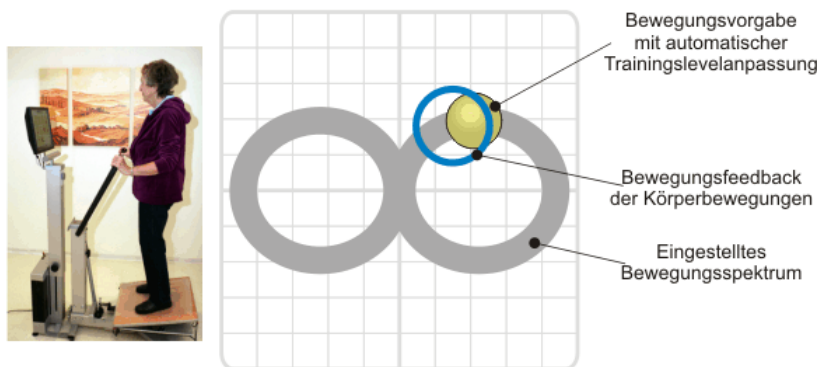
day 2 after surgery, the knee can be moved with caution by a motor-driven continuous motion device, so called CPM. The patient should wear a hinged brace attached by adhesive bands (orthosis) for approx. 6 weeks. Intensive physical therapy is necessary to regain full motion and to strengthen the musculature. Depending on the surgical technique used and the individual healing process, the patient can start jogging 2 – 4 months after surgery. At this time, the patient is fit to exercise general sports. Specific sports, however, may need a recovery time of 4 – 8 months. Depending on the strain at work, the person will be on sick leave for 4 weeks to 6 months.

Physiomat measures coordination

The assessment of coordination was done with a computerized flexible plate (Physiomat) after 6 and 12 weeks. Patients made several specific exercises. The Physiomat® produced by German manufacturer EPL is a further development of the conventional vibrating plate. It doesn't only vibrate, it also has two movable measuring plates with movement feedback. A flat screen on the machine shows the user which exercises to carry out, and how he or she performed.

The results are saved, allowing training progress to be documented.

During the assessment of coordination the patients stood with both feet on the movable plates und tried to keep a cursor, which was directed by the plates, inside a circle on the flat screen. The number of hits in two minutes was documented as percentage points, i.e. 100 percent is the maximum value. The final result is the difference between the 12-weeks and the 6-weeks value.



Data

Age	sex	Body height in centimeter	weight	Study group Physiomat 12 - 6	Control group Physiomat 12-6 weeks
36	m	186		81	25
31	F	175		76	39
39	F	161		63	11
20	F	163		60	12

32	m	182	81	15	
33	F	162	69	11	
23	m	179	88	15	
40	m	190	106	6	
23	m	161	72	46	
25	F	172	95	20	
27	F	176	79	17	
24	m	176	52	8	
36	F	157	53	24	
16	m	183	102	23	
27	F	179	88	23	
18	F	157	83	22	
31	m	181	77	9	
28	m	167	59	5	
16	m	174	72	16	
15	F	161	86	19	
20	m	164	76	6	
16	m	187	93	25	
20	m	171	71	13	
19	m	161	69	12	
16	F	174	82	26	
21	F	172	64		15
17	m	174	77		9
16	m	183	61		8
19	m	171	62		4
18	m	188	90		4
21	m	169	67		1
17	F	158	65		20
23	m	186	84		17
24	F	177	71		7
24	m	184	97		11
16	m	167	62		5
17	F	176	62		5
21	F	164	68		3
17	F	159	66		13
18	m	172	78		8
23	F	175	101		5
24	m	176	77		7
26	m	182	92		13
21	m	191	109		8
18	m	183	85		6
25	F	163	81		3
22	m	178	92		2
22	m	165	55		12
26	F	167	63		10
16	m	174	98		5
23	m	165	57		7

22,8627451

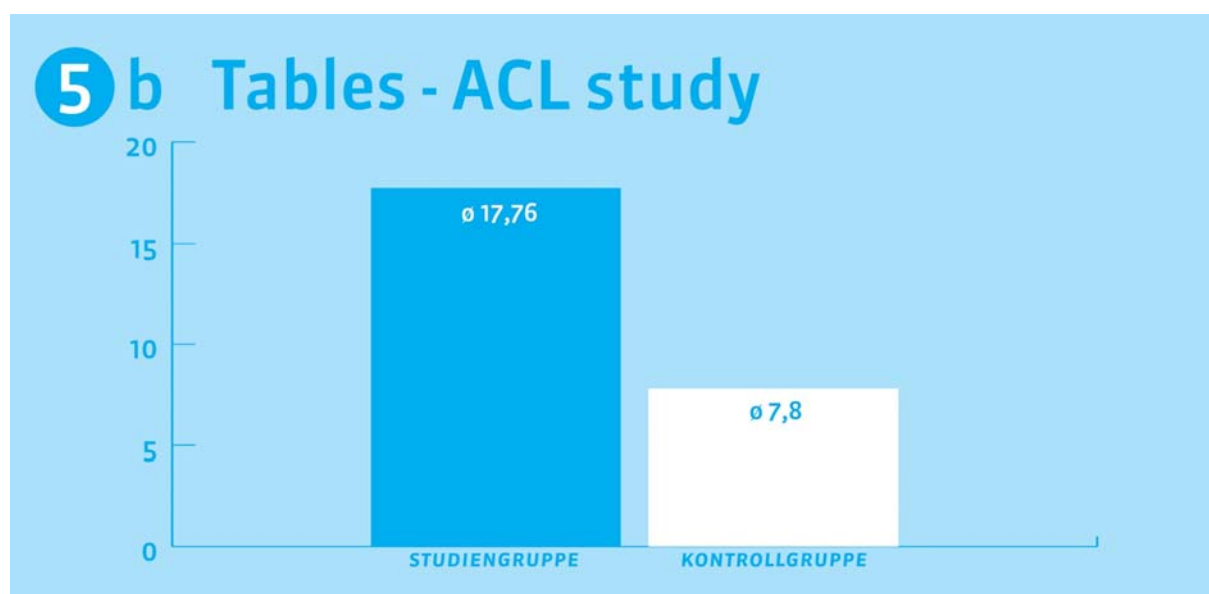
172,901961 76,8039216

17,92

8

Results

The coordination value for the study group in the ACL study was 18, for the control group 8. The difference is statistically significant ($p < 0,01$). The patients with the rocker sole shoes achieved a clear higher level of coordinative abilities. This may contribute to a shorter rehabilitation period and an earlier comeback to work or sports.



Conclusion

The AuBioMo® shoe is a valuable therapy option in the rehab protocol after knee surgery. There is a high patient satisfaction and compliance, no adverse effects and low costs. Furthermore, in an application observation very high values of satisfaction were found.

Discussion

The AuBioMo® shoe should be used much more often in the rehab protocol after knee surgery, if possible in the context of scientific studies. It seems to be useful to combine those studies with the measurement of muscle activities. It should be also interesting to find out, which role the AuBioMo® can play in preventing injuries.

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