

MANUAL

Test for Substitution Patterns, TSP

The Test for Substitution Patterns (TSP) is a quantifiable observation test of movement quality in the assessment of postural orientation (sometimes referred to as alignment). In the TSP the inter-relationship between the body segments and the relationship between the body and the environment are assessed while performing weight-bearing movements. Predefined and specific movement alterations, called substitution patterns (SP), are identified and interpreted as unfavorable strategies since such alterations have been found to be associated with negative consequences, for example knee osteoarthritis (Tanamas et. al. 2009, Does knee malalignment increase the risk of development and progression of knee osteoarthritis? A systematic review. *Arthritis and rheumatism* Apr 15 2009;61(4):459-67). The inter-rater and intra-rater reproducibility of the TSP has in double blinded testing been found to be good at a group level. A satisfactory degree of evidence of validity has been collected (see references 1-3 below).

Reference no. 1 and 2 shall be used as references when using TSP:

1. *Trulsson A, Garwicz M, Ageberg E. Postural orientation in subjects with anterior cruciate ligament injury: development and first evaluation of a new observational test battery. Knee Surg Sports Traumatol Arthrosc. Jun 2010;18(6):814-23*
2. *Trulsson A, Roos EM, Ageberg E, et al. Relationships between postural orientation and self reported function, hop performance and muscle power in subjects with anterior cruciate ligament injury. BMC Musculoskelet Disord. 2010;11:143.*
3. *Trulsson A. Altered movement patterns and deviating muscular activity in individuals with anterior cruciate ligament injury [Dissertation]. Faculty of Medicine: Physiotherapy, Lund University; 2015.*

To be able to obtain the best possible degree of validity and reproducibility of the TSP scoring, the examiner should study the theory, content and construct of the TSP and also practice the scoring and the performance of the test movements thoroughly until an adequate reproducibility of the scoring is reached (reference 1-3). Also, the same examiner should examine the patient when the TSP is repeated over time.

Five test movements are used in the TSP: 1) Bodyweight altering test, 2) Single leg squat tip-toe standing, 3) Single leg squat, 4) Forward lunge form stair and 5) Double leg squat. The patient performs test movements no.1-3 and 5 barefooted and no. 4 in shoes/trainers, and is dressed in clothes allowing the examiner to identify movement alterations. The examiner observes and scores the substitution patterns as described below for each test movement 1-5. The scoring is based on identification of substitution patterns when comparing injured and non-injured (or right and left) sides on a four-point ordinal scale, 0–3:

“0” = no SP present

“1” = SP possibly present (meaning an experienced examiner can identify the SP)

“2” = SP clearly present (meaning an inexperienced person, for example the patient him/herself, would be able to identify the SP)

“3” = SP very clearly present means that a patient performed very poorly (i.e. when a patient cannot perform the test the predefined number of times or performed so poorly that it could not be scored as a “2” or that there is no similarity to the task).

In order to be scored as “1”, “2” or “3”, an SP should be identified in the majority of the repetitions. If the examiner is uncertain of the scoring after five repetitions, the examiner can ask the patient to perform the test movement a further 5 times. If this is the case, the last 5

repetitions are used in the scoring. If the patient declines to perform a test movement due to reasons associated to the leg-problems, this is scored with a “3” and the word “MISSING” is noted in the “comments” in the scoring sheet. The TSP total score is the sum of scores awarded for all five test movements with a possible range of 0 – 54 points.

In the manual below, the verbal instructions given by the examiner are in italics. In the scoring sheet, a short version of the examiners’ instructions can also be found (in italics). The examiner demonstrates each test movement, and gives the verbal instructions word by word. The patient is not allowed to try out the test movements before the scoring and is not given any information on what is scored (the SP) during testing. Each test movement is performed 5 times on each side, starting with the non-injured side; test movement no. 1 and 4 is performed alternating the sides and no. 2 and 3 is performed with all 5 repetitions on one side first and then on the other side. Test movement no. 5 is performed bilaterally. If the TSP is to be repeated, the test movements should always be performed in the same initial order.

In the first study evaluating TSP, the test-concept consisted of 9 test movements, labeled A-J (reference 1,2). Five of these showed an ability to discriminate between patients and uninjured individuals. These five test movements are in the initial studies described using capital letters B, C, E, G, J, corresponding to numbers 1-5 in this manual and in the scoring sheet (B=1, C=2, E=3, G=4, J=5).

Test movements 1-5

The five test movements of the TSP are performed at a pace of about 25 beats/minute: performance on beat one, return to starting position on beat two. Below: *Verbal instructions given by the examiner are written in italics*, starting positions = S, performance = P.

1 — Bodyweight altering test

S: Patient barefooted standing with feet a good hip-width apart. Hands placed on head. Examiner standing in front of patient.

P: Examiner: *“Shift your body weight from non-injured leg to injured leg at the same time as you bend the weight bearing leg slightly at ankle, knee and hip joints. Do this alternating towards the non-injured and injured side; five times on each side. Look straight ahead.”*

Substitution patterns scored:

1:1. Increased outward rotation and/or pronation on weight bearing foot

1:2. Knee moves medially in relation to the foot and hip (knee not in line with hip and foot) when weight bearing

1:3. Lateral displacement of hip–pelvis region on weight bearing side

1:4. Displacement of trunk (for instance bending trunk forward or displacing trunk laterally) on weight bearing side

1:5. Different positions of arms when comparing arm positions to trunk; look at how elbows are placed in relation to trunk, for example placed more lateral or more forward on weight bearing side as compared to when other side is weight bearing

2 — Single leg squat tip-toe standing

S: Patient barefooted facing wall, standing tip-toe on one foot. Slight support from fingertips against wall in front of patient. Examiner standing behind and then beside patient on weight bearing side.

P: Examiner: *“Squat slowly about this much (demonstrating approx. 70 degrees of knee flexion) without lowering the heel. Five repetitions.”*

Substitution patterns:

- 2:1. Knee moves medially in relation to the foot and hip (knee not in line with hip and foot) when weight bearing
- 2:2. Lateral displacement of hip–pelvis region on the weight bearing side
- 2:3. Displacement of trunk (for instance bending trunk forward or displacing laterally) on weight bearing side

3 — Single leg squat

S: Patient barefooted standing on non-injured leg beside for example a bench or wall on opposite side to weight bearing leg and fingertips (of opposite hand to weight bearing leg) providing light balance support on bench/wall. Non weight bearing leg slightly raised from the floor by slight hip and knee flexion. Examiner standing in front of and then beside patient on weight bearing side.

P: Examiner: *“Squat on your leg about this much (demonstrating approx. 70 degrees of knee flexion) and rise five times. Turn around and repeat the procedure on the other leg.”*

Substitution patterns:

- 3:1. Increased outward rotation and/or pronation on weight bearing foot
- 3:2. Knee moves medially in relation to the foot and hip (knee not in line with hip and foot) when weight bearing
- 3:3. Lateral displacement of hip–pelvis region on weight bearing side
- 3:4. Displacement of trunk (for instance bending trunk exaggeratedly forward or displacing trunk laterally) on weight bearing side

4 — Forward lunge from stairs

S: Patient standing with shoes, on first step of a staircase (about 15 cm high). Examiner standing in front of patient observing both the “stride” and the “return”.

P: Instructions: *“Take a long stride forward to the floor (demonstrating about 80 cm from the step) with the non-injured leg and land on the foot at the same time as you bend this knee to about 90 degrees of flexion (called “stride” in scoring sheet), while the foot of the injured leg remains on the step. Remain in this position for about 2 seconds, and then return to the step (called “return” in scoring sheet). Alternate between the non-injured and injured legs. Five times on each side.”*

Substitution patterns:

- 4:1. Shorter stride
- 4:2. Knee moves medially in relation to the foot and hip (knee not in line with hip and foot) when weight bearing
- 4:3. Displacement of trunk (for instance bending trunk forward or displacing laterally) on weight bearing side
- 4:4. Patient tries to help out with support from hand/hands or takes a more careful stride (sound muffled when foot meets floor)
- 4:5. Avoids weight-bearing on hind leg during return

5 — Double leg squat

S: Patient barefooted standing with feet a good hip-width apart. Examiner standing in front of patient.

P: Examiner: *“Squat on both legs this much (demonstrating approx. 90 degrees of knee flexion), and rise up again five times”*

Substitution pattern:

- 5:1. Displacement of bodyweight away from scored side

TEST FOR SUBSTITUTION PATTERNS, TSP

Name _____ Date _____ Examiner _____

	LEFT	Substitution patterns (SP)			RIGHT	Substitution patterns (SP)			COMMENTS
TEST MOVEMENT:	0=no SP	1= possibly present	2= clearly present	3= very clearly present/can not	0=no SP	1= possibly present	2= clearly present	3= very clearly present/can not	
Performed in the pace of 25 beats/minute									
1. Bodyweight altering test. <i>Shift body weight from right to left leg bending the weight bearing (w b) leg; hands on head, look straight ahead. 5 reps</i>									
1:1 increased outward rotation/pronation of w b foot									
1:2 knee moves medially on w b side									
1:3 lateral displacement hip/pelvis w b side									
1:4 displacement of trunk on w b side									
1:5 different arm-/elbow position on w b side									
2. Single leg squat tip-toe standing <i>Squat about this much (demonstrate ≈70° of knee flexion) without lowering the heel. Fingertip support. 5 reps.</i>									
2:1 knee moves medially on w b side									
2:2 lateral displacement hip/pelvis on w b side									
2:3 displacement of trunk on w b side									
3. Single leg squat. <i>Squat about this much (demonstrate ≈70° of knee flexion) and rise five times. Turn around and repeat on the other side. Slight fingertip support opposite hand. 5 reps.</i>									
3:1 increased outward rotation / pronation w b foot									
3:2 knee moves medially on w b side									
3:3 lateral displacement hip/pelvis on w b side									
3:4 displacement of trunk on w b side									
4. Forward lunge from stairs <i>Long stride out onto floor (≈80 cm) land on right leg while flexing ≈90° (stride), other leg remains on the step. 2 sec. Return to the step (return). Alternate right/left 5 reps/side.</i>									
4:1 stride: shorter stride									
4:2 stride: knee moves medially on w b side									
4:3 stride: displacement of trunk on w b side									
4:4 stride: help from hands/careful stride (sound)									
4:5 return: avoids weight bearing on hind leg during return									
5—Double leg squat. <i>Squat on both legs (demonstrating ≈90° knee flexion), rise up, 5 reps.</i>									
5:1 displacement of bodyweight away from scored side									