

Supplementary file 1, The core strengthening program

Exercises	Characteristics	Justification
Cat/camel	Cycles of flexion and extension in quadruped position.	Cat/camel reduces spinal viscosity (14).
Abdominal muscle contractions in supine and quadruped. Side bridge	Activation of the deep core musculature in static positions.	The local system consists of mostly type I tonic muscles which are activated with low intensities and slow movements (15). These muscles therefore require exercises that involve little to no motion through the spine and pelvis (16). The side bridge and bird dog exercises produce muscle activation in the absence of external loading to train stabilisation and endurance to the musculature of the torso and hips (17).
Dead bug Bird dog	Maintenance of core control while performing controlled arm and leg movements.	
Hip abduction	Activation of the hip musculature while maintaining lumbar and pelvic control.	Hip abduction is an effective non-weight-bearing method for isolating function and strength training of the gluteus medius muscle (17).
Abdominal isometric contraction on a Swiss ball.	Maintenance of core control in an unstable environment.	Given that isolation exercises of the local musculature tend to be in non-functional positions, exercise training that shifts to additional functional positions and actions is required as a progression, which initiates training of the global system (16).
Lunges	Maintenance of lumbar control during hip movement.	
Directional lunges and oblique twists	Maintenance of lumbar control during multiplanar movements.	Exercises that produce dynamic concentric and eccentric movement of the spine emphasise the global system musculature while providing an environment for the local system to stabilise the spine in a variety of multiplanar movements (16).
Trunk twists on a Swiss ball	Maintenance of core control during movement in an unstable environment.	
Trunk twists with theraband on Swiss ball	Progress to movement under resistance in an unstable environment.	

Exercise	Week 1		Week 2		Week 3		Week 4		Week 5		Week 6		Week 7		Week 8	
	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Warm up																
Cat/camel	1	6	1	6	1	6	1	6	1	6	1	6	1	6	1	6
Activation of core musculature																
- Supine	2	15	2	15	2	15	2	15	2	15	2	15	2	15	2	15
- Quadruped	2	15	2	15	2	15	2	15	2	15	2	15	2	15	2	15
- Side bridge (on knees)	1 (10s holds)	6	1 (10s holds)	6 (10s holds)	1 (10s holds)	6	1 (10s holds)	6	1 (10s holds)	6	1 (10s holds)	6	1 (10s holds)	6	1 (10s holds)	6
Dead bug																
Supine position	Supported position, extend 1 arm and flex opposite knee and hip to 90°	Supported position, extend both arms over head	Supported position, hands clasped, extend arms over head	Supported position, hands clasped, extend arms over head	Unsupported position, hands clasped, extend arms over head, extend 1 leg	Unsupported position, hands clasped, extend arms overhead, extend both legs	Unsupported position, hands clasped, extend arms overhead, extend both legs	Unsupported position, hands clasped, extend arms overhead, extend both legs	Unsupported position, extend opposite arm and opposite leg							
Supported position - knees bent and feet placed on floor																
Unsupported position - feet raised from floor with knees and hips bent at 90°																
Hold time	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s	2s
Duration	30s	45s	60s	60s	60s	75s	90s	90s	90s	90s	90s	90s	90s	90s	105s	105s
Side bridging																
On side, forearm on floor, elbow under shoulder	Raise hips 3cm off floor with knees bent at 90°	Raise hips 8 cm off floor (max bridging height) with knees bent at 90°	Raise hips 8 cm off floor (max height) with legs straight	Raise hips 8 cm off floor (max height) with legs straight	Raise hips 8 cm off floor (max height) with legs straight and extend 1 leg	Raise hips 8 cm off floor (max height) with legs straight and extend 1 leg, add 0.5kgs to legs	Raise hips 8 cm off floor (max height) with legs straight and extend 1 leg, add 0.5kgs to legs	Raise hips 8 cm off floor (max height) with legs straight and extend 1 leg, add 0.5kgs to legs	Raise hips 8 cm off floor (max height) after each side bridge hold, "roll" from one elbow to the other.							
Sets	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side	3 each side
Duration	30s	45s	20s	20s	30s	30s	30s	30s	30s	20s	20s	30s	30s	30s	60s	60s

Birdog exercises	Raise one leg at a time, repeat with other leg then, raising each arm at a time	Raise opposite arm and opposite leg	Raise opposite arm and opposite leg	Raise opposite arm and opposite leg, refrain from placing limbs back on ground between sets	Raise opposite arm and opposite leg, refrain from placing limbs back on ground between sets	Raise opposite arm and opposite leg, add 0.5kg leg weight	Raise opposite arm and opposite leg, add 0.5kg leg weight	Raise opposite arm and opposite leg, add 1kg leg weight
In quadruped position (four point kneeling)								
Sets	3 on each limb	3 on each side	3 on each side	3 on each side	3 on each side	3 on each side	3 on each side	3 on each side
Duration	20s	20s	30s	15s	20s	20s	30s	30s
Hip abduction	Raise and lower top leg.	Raise and lower top leg.	Raise and lower top leg.	Raise and lower top leg.	Raise and lower top leg.	Raise and lower top leg with 0.5kg leg weight	Raise and lower top leg with 0.5kg leg weight	Raise and lower top leg with 1kg leg weight
Lying on side, core muscles activated, legs extended.								
Sets	2 each side	3 each side	2 each side	3 each side	3 each side	2 each side	3 each side	3 each side
Reps	10	10	15	15	15	15	15	15
Stability ball exercises	Seated on stability ball while activating core musculature	Seated on stability ball while activating core musculature	Squat with stability ball 90° hip and knee flexion	Squat with stability ball 90° hip and knee flexion	Diagonal curls on stability ball	Diagonal curls on stability ball	Twists on stability ball holding a medicine ball	Twists on stability ball with theraband
Sets	3	3	3	3	3	3	3	3
Duration	30s	30s	Reps 15	Reps 15	Reps 10	Reps 15	Reps 10	Reps 10
Lunges/obliques	Lunges with 2kg weight in each hand	Lunges with 2kg weight in each hand	Lunges at 45°	Lunges at 45° with a 2kg weight in each hand	Lunges to sides	Lunges to sides with 2kg weights in each hand	Oblique pulley twist with theraband	Oblique pulley twist with theraband
Sets	3	3	3	3	3	3	3	3
Reps	10	10	15	10	15	10	10	15

(1, 14-20)