



Early Introduction Of Graded Unilateral Squats Training In Post Traumatic Brain Injury Hemiparetic Patient - A Case Report

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Abstract:

Gait training to facilitate the use of the paretic limb for persons with hemiparesis continues to be of interest to those in the clinical research domain. The purpose of this case report was to assess the outcomes of a repeated unilateral squats treatment, initiating with the paretic limb, on functional mobility, endurance and gait kinematic parameters in a person with hemiparesis. The participant was an 40-year-old male 7 months status post right hemiparesis a K/C/O traumatic brain injury (diffuse axonal injury), who reported overall good health. Patient's main complaint was difficulty in moving right upper and lower limb since 7 months (LL>UL).

The participant was asked to perform unilateral squats with his paretic limb initially with maximal, moderate and minimal support and once he was confident enough, then without support. The training duration for each treatment session was 10-15 min/day in outpatient rehabilitation. The participant completed ten sessions spanning over 3 weeks. The outcome measure used to identify motor recovery was with the help of Lower extremity functional scale (LEFS). In addition, timed up and go test, 6-min walk test (6 MWT) and gait kinematics were assessed to examine mobility and gait. The Lower extremity functional scale (LEFS) score, 6 MWT and Timed up and go test showed a meaningful change. With respect to gait kinematics, hip flexion on the paretic limb was improved. Unilateral squats training seemed to be an effective treatment to improve strength, co contraction, alteration of strength and range of contraction of the agonists and antagonists of lower extremity when it is appropriately targeted and started early in the intervention. The patient's level of assistance for mobility and activities of daily living improved from minimal assistance to modified independence without use of an assistive device.

Keywords: unilateral squats, strength, motor function, hemiparesis, stroke, 6 MWT, TUG, LEFS.

Introduction:

Traumatic brain injuries (TBIs) are the serious threats to the human lives. It is estimated that nearly 69 million individuals sustain traumatic brain injuries on an average worldwide. In India, according to the NIMHANS statistics nearly 1 million cases are sustained with traumatic brain injuries, 2,00,000 individuals lose their lives and nearly 1 million sustained require extensive rehabilitation. This signifies the severity of the traumatic brain injury patients. ⁽¹⁾

Conservative management in case of mild TBIs and extensive surgical interventions followed by extensive post surgical or medicinal rehabilitation is required inadvertently by the survivors.

Unlike stroke, where 95% of stroke results in to hemiparesis/hemiplegia, TBIs result in to quadriplegia/quadruparesis, hemiplegia/hemiparesis, monoplegia/monoparesis, with symmetrical/ unsymmetrical involvement depending on the level, extent, and site of the lesion. This is accompanied by cognitive, perceptual and higher cortical impairments which make management more complicated

and Multicentric. ⁽¹⁾ Diffuse axonal injuries are the type of TBIs where there is widespread damage to the brain neurons and scattered clinical presentation. The presenting case is a K/C/O diffuse axonal injury (DAI) as mentioned in the MRI scan dated with alleged motorcycle accident. Ironically the patient presented with hemiparesis with minimal cognitive impairment (RLA score= 8). This may be evident by sparing of deep seated structures and mere involvement of seventh cranial nerve.

Unilateral squats are one of the closed kinematic chain exercises of lower limb. These exercises are performed in weight bearing with a controlled decent and ascend back to the normal standing. Optimum sensory i.e. proprioceptive, kinaesthetic awareness, adequate single leg standing balance and swift muscle work is utmost necessary for carrying effective unilateral squats. Hemi paretic patients specifically precipitated through TBI may get difficulty in performing this high skilled exercise due to possible muscle weakness, tonal abnormality irrespective of synergy, and abnormal synergistic action and the consequent affection in the balance. Unlike the hemiparesis in stroke the involvement of typical synergies is not there in this case. The illustration is given in the specific assessment criterion. Thus the exercise should be administered with utmost precaution, in controlled supervision and gradually increasing the level of difficulty. It is observed that in routine physiotherapy practice, the unilateral squats are used as an adjunct for improving balance or for gait training. Addition of unilateral squats to the early routine physiotherapy management in case of hemi paretic patients may improve the lower extremity function, speed of gait, early gain of voluntary control and smooth transition of movements from one group of muscles to other by breaking abnormal synergies and tone. There is minimal evidence of utilization of unilateral squat training to both lower limbs with gradual increase in difficulty. First with maximal support and then weaning the support slowly and adding the difficulty in the form of positions and weight or surface ground may

have positive short term impact on the functional activity, endurance and gait parameters. Hence this study was aimed to explore incorporation of unilateral squats in early stage and gradually varying the difficulty along with routine exercise protocol for effective lower extremity function in hemi paretic DAI patient.

Patient Information:

40-year-old male, driver by occupation, right hand dominance having difficulty in moving right upper and lower limb. The patient was a known case of hypertension since 1 year. The insidious history of TBI dated 22 June 2020 with grade 3 DAI at left Pons with mild subarachnoid haemorrhage on right and bilateral occipital lobes along with corpus callosum contusion as reported in MRI scan dated 23 June 2020. (Reports are attached in annexure). The patient had hospital stay of 20 Days and discharged on 11th July 2020. The patient had given a history of missed doses of antihypertensive Tab. Telma 40 couple of days before injury (that was the presumed cause of giddiness for the accident) (but no evidence of cerebro vascular accident noted in the MRI reports) with no significant past, personal and psychological history. The patient was on physiotherapy treatment from 5th Aug. 2020 till 10th Feb. 2021.

Clinical Findings:

Significant physical examination (PE) and important clinical findings Observation – Posture – Flat foot, left arm waist distance reduced Attitude of limb - in supine lying, lower limb externally rotated head tilted towards the affected side, stable vitals, with no significant tropic changes and muscle wasting.

Specific neurological examination - higher mental function

Patient was conscious, oriented to time, place and person, attentive and well co-operative to the commands addressed.

All the other cranial nerve functions were intact except 7th cranial nerve, in which slight deviation of angle of mouth was noted with House Brackmann scale grade 2. All the superficial, deep and combined cortical senses were normal.

Motor examination (specific significant clinical findings)

Tone assessment: on the basis of modified ashworth scale

Upper and lower extremity muscle groups	Right Side	
	Start of the treatment (Oct.2020)	End of course duration of case study (Feb. 2021)
shoulder flexors	1+	1
elbow flexors	1	0
elbow extensors	0	0
wrist flexors	1+	1
wrist extensors	1+	1
hip flexors	1+	0
hip extensors	1	0
knee flexors	1+	0
knee extensors	1+	1
ankle dorsi flexors	1+	0
Ankle plantar flexors	1+	1

Tightness

Muscle	Right side	
	Start of the treatment (Oct.2020)	End of course duration of case study (Feb. 2021)
Biceps	Present	Not present
Neck Flexors	Present	Not present
Neck Extensors	Present	Not present
Iliopsoas	Present	Not present
Hamstrings	Present	Not present
Quadriceps	Present	Not present
Gastrocnemius And Soleus	Present	present
Tender Achilles	Present	present

Range of motion

	right active	right passive	left active	left passive
shoulder flexion	130 degrees	135 degrees	160 degrees	170 degrees
shoulder abduction	60 degrees	90 degrees		
medial rotation	50 degrees	60 degrees	70 degrees	75 degrees
elbow flexion	140 degrees	150 degrees		
hip abduction	35 degrees	45 degrees	40 degrees	45 degrees
hip flexion	55 degrees	90 degrees	100 degrees	110 degrees
lateral rotation	40 degrees	45 degrees		
medial rotation	30 degrees	35 degrees		
knee flexion	100 degrees	120 degrees		
knee extension	100 to 5 degrees	100 to 0 degrees		

Voluntary control

LIMB	Right side	
	Start of the treatment (Oct.2020)	End of course duration of case study (Feb. 2021)
UPPER	4	5
LOWER	4	5

All the above examinations for the left side were within the normal limit. Reflexes were 3+ initially in right side for biceps, and knee

jerks which got integrated later in the treatment course. All the superficial reflexes were normal.

Coordination tests:

Finger to nose not able to perform
 Finger to therapist finger not able to perform
 Finger to finger- not able to perform
 Alternate nose to finger- not able to perform
 Pronation and supination - able to perform
 Hand tapping- not able to perform
 Foot tapping- not able to perform
 Alternate heel to knee- not able to perform
 Heel to toe- not able to perform
 Heel on shin- not able to perform
 Drawing a circle- not able to perform
 Later on during the treatment course the patient could perform the entire coordination test except drawing a circle.

Berg Balance Scale:

	Right side	
	Start of the treatment (Oct.2020)	End of course duration of case study (Feb. 2021)
Score	42	54

Gait-

Initial examination: Arm swing reduced, stance of right extremity increased, swing phase of right lower extremity reduced, left lower extremity externally rotated, with the typical gait deviating out of typical Circumduction gait.

Post treatment examination: the patient improved with the Circumduction gait with alternate arm swing, cadence 112/min and normal gait velocity. The initial knee hyperextension component was integrated and there was no lurch and delay in the stance and swing time with appropriate completion of phases of gait.

Short term goals the general short term goals at the time of commencement of treatment of unilateral squat.

: normalize muscle tone of right lower extremity and upper extremity
 inculcate isolation movements.
 encourage active range of motion of right lower limb and upper limb

facilitate muscle strength
 hand function maintenance and enhancement
 incorporate tasks similar to activities of daily living
 cessation of alcohol and smoking
 prevention of complication

Long term goals

Promote functional independence in activities of daily living especially locomotor wash room and grooming activities
 Promotion of overall body fitness to increase cardiovascular endurance

General Physiotherapeutic line of treatment:

1. Shoulder assisted exercises(ladder exercise ,shoulder wheel, wrist roller, shoulder flexion with Swiss ball)
2. Shoulder stretching
3. shoulder PNF
4. Quadriceps chair
5. Rowing chair exercise
6. heel slides
7. Pelvic bridging
8. Gait reeducation
9. Mobility exercises of spine, upper limb and lower limb
10. Weight shifting on foam
11. One leg standing balance
12. Mini squats wall supported
13. Balance on wobble board
14. Single leg pelvic bridging
15. Inclined Wall pushups
16. Quadruped reach outs
17. Kneeling to standing on one leg
18. Agility drills
19. balance training

Along with this general line of treatment unilateral squats were given to the patient on both lower extremities alternately (not allowing full squats). The assistance was decreased gradually as the patient confidence boosted up. And the difficulty in the form of addition of resistance like dumbbells or positions or level of surface changed as a part of progression in the duration of 4 months.

Timeline and interventions:

Prescription of unilateral squats to both lower extremities alternately (protocol as follows)

	1 st month Oct. –Nov. 2020	2 nd month Nov. – Dec. 2020	3 rd month Dec. 2020- Jan. 2021	4 th month Jan. 2021-Feb. 2021
Assistance	Maximal in parallel bars, and with therapist's support	Moderate in parallel bars with minimal therapist support	Minimal with guarding in parallel bars	Out of parallel bars with therapist guarding but not supporting the patient
Resistance	-	In the form of upperlimb movements(bilateral shoulder flexion)	Manual resistance by therapist	Dumbbells 0.5-2 kg progressively
Surface	Level surface	Level surface	Wedge incline	Wobble board
Repetition	20 repetitions/ set, 2 sets/session/day, 5 days/week	20 repetitions/ set, 2 sets/session/day, 5 days/week	20 repetitions/ set, 2 sets/session/day, 5 days/week	20 repetitions/ set, 2 sets/session/day, 5 days/week
Days of treatment attended by patient	25	23	23	18 due to lockdown in COVID.

Diagnostic challenges

Due to covid pandemic situations, patient was not continuous to the clinic due to which it was a limitation and challenge in assessment. In the due course of 7 month total treatment, patient was very irregular for first 3 months due to lockdown. The documentation and record maintainance was not done due to aforesaid situations. The last four months patient was regular hence a detailed assessment and treatment was given in this span and the report was formulated.

Diagnosis: Right Hemiparesis (LL>UL) secondary to Traumatic brain injury (DAI, corpus callosum contusion)

Prognosis: good.

Rationale: The patient was nil of any cognitive/ perceptual impairment and sustained hemiparesis.

Therapeutic Intervention:

Therapeutic intervention: unilateral squats in the parallel bar were initially given to the patient with not allowing the knee move ahead of the toe. With core engaged and trunk up throughout the movement and instructing the patient to squeeze the gluteal muscles as he pushed to stand back up, performing 20

reps on this on right side before switching to the left. The protocol was progressed as mentioned in the timeline for 20 repetitions/ set, 2 sets/session/day, 5 days/week.

Changes in therapeutic intervention: variations with dumbbells, medicine ball etc in hand or resistance band around the thigh or on foam with varying position of upper extremity made it more challenging which inculcates other muscles and makes it a compound exercise and strengthens other muscles too. The single-leg squat works the following muscles: glutes, calves, thighs, abdominals

The outcome measure: Lower extremity functional scale (LEFS). In addition, timed up and go test, 6-min walk test (6 MWT) and gait kinematics were assessed to examine mobility and gait.

Follow-up and Outcomes:

Important follow-up diagnostic and other test results: With respect to gait kinematics, hip flexion on the paretic limb was improved. Improvement was observed in all components of Lower extremity functional scale (LEFS) i.e. from grade 2 (Moderate Difficulty) to grade 0 (No Difficulty) after giving 4 weeks of intervention. The 6 minute walk test results

also improved from 200 meters to 350 meters. The timed up and go test was also improved from 98 sec. To 30 sec. Also the gait parameters were improved to the observable range.

Discussion:

Due to covid, patient was not continuous to the clinic due to which it was a limitation and challenge in intervention. For the first 3 months patient was highly irregular. This was the difficulty to assess him thoroughly and decide the plan of treatment.

There is sufficient literature on the unilateral versus bilateral squat training in different conditions like low back pain, post ACL reconstruction rehabilitation etc. Short of evidence was found in the neurological conditions i.e. hemiparesis. The unilateral squat exercise incorporation has improved all the outcome measures as mentioned before when added early in the intervention plan. The uniqueness of the case study was the utilization of both affected and unaffected extremity and a structured progressive protocol of the unilateral squats in the treatment. This is accompanied with the other treatment techniques also. Hence it is not sole effect of unilateral squats on the outcome measures. Nevertheless, the high level of straight ground reaction forces imposed on the leg with unilateral squats may increase strength and rate of force development.^(2, 3) This might have improved the endurance and quickness in the movement. Involvement of both legs alternately in the treatment may have improved gait parameters. And the overall impact was on the lower extremity function scale. The mirror exercises in parallel bar may have helped along with the cues to the patient to balance and equally weight bear on the extremities with improved posture and minimization of trick movements. The advantage of selecting this patient that, in

spite of TBI he was not having any cognitive, perceptual co morbidity in the treatment duration. Further studies should be taken with consideration of this protocol for assessing the isolated effect of unilateral squats on various conditions.

Conclusion:

This case study suggests that unilateral squats training is effective in improving lower-extremity impairments, endurance, gait and spontaneity in hemiparetic population.

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Annexure:1 Discharge Summary From Hospital

Medicolegal Case: MLC No.:381/2020

Diagnosis:
Road Traffic Accident (V89.2XX) with Head Injury (S09.90XA) with Corpus Callosum Contusion (S06.339A)
with Grade III Diffuse Axonal Injury (S06.2X2) with Renal Parenchymal Disease Grade II (N28.9)

Complaints on Admission:
A 39 years old male patient admitted at Neuron hospital with A/H/O - RTA on 22/6/2020 at 11:30 am at Khamla Road. Patient was driving his 2 wheeler, RTA due to skidding of bike resulting head injury. Primary shifted to Padole Hospital then shifted to Neuron Hospital for further treatment and management.

On admission: Gasping respiration, pupils unequal
K/C/O - HTN
K/C/O - Liver abscess (Jan 2020) at Aureus Hospital
NO History of COVID19 contact
History of travelling Balaghat Trip with medical certificat
NO H/O - Fever/Cough
Now, admitted here for further treatment and management.

On Examination:

General Condition:	Moderate
Body Temperature:	Afebrile
Pulse:	80/min
BP:	120/80 mmHg
RR:	18/min
RS:	Chest clear
CVS:	S1,S2 (N)
P/A:	Soft
CNS:	Unconscious, flexion left UL to DPS, Right side hemiparesis

Annexure 2: CT scan Brain

Date _____

CT SCAN BRAIN

FINDINGS:

Subtle subarachnoid bleed in right parietal sulcal spaces.

Skull vault is normal.

Posterior fossa structures, cerebellum, brainstem and fourth ventricle do not reveal any abnormality.

Cerebral hemispheres show normal grey to white matter discrimination.

Ventricular system appears normal.

Midline structures are normally oriented.

Sella and supra-sellar regions appear normal.

Visualized parts of the paranasal sinuses and orbits appear normal.

Annexure 3: MRI Scan