

Post-Stroke Lower Limb Length Discrepancy: A Complication in Patients with Hemiparesis

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Abstract: A stroke without prompt physiotherapy may result in contractures and/or other preventable complications, which may further affect functional ability. Asymmetric standing posture with weight transference to the non-paretic lower limb is peculiar with stroke patients. A secondary Limb-Length Discrepancy (LLD) in stroke has not been reported. The study looked if LLD could be a complication after stroke in physiotherapy neglected cases. Twelve stroke patients (2 Right, 10 left; 9 males, 3 females; mean age: 63.42 ± 9.10 years) who presented late for physiotherapy participated in the study. Their length of stay before physiotherapy management ranges from 3-72 (mean 20.70 ± 20.30) months. A true leg length measurement (from anterior superior iliac spine to the medial malleolus) bilaterally, revealed insignificant LLD ($p > 0.05$), but when correlated with extension lag of the paretic knee joint showed significance ($p < 0.05$). LLD could result as a post-stroke complication-a long term effect in physiotherapy neglected cases, from reduced ROM of the non-paretic limb. Early physiotherapy (with quadriceps muscle exercises) of stroke patients is advised. Further studies with more accurate and reliable measurements are recommended.

Key words: Stroke complications, limb length discrepancy, range of motion, weight shift, late physiotherapy

INTRODUCTION

Complications following acute stroke have been clinically observed and are related to poor outcome (Johnston *et al.*, 1998; Doshi *et al.*, 2003). Medical complications that follow ischemic stroke not only influence mortality but may influence functional outcome (Johnston *et al.*, 1998). In a prospective cohort study, specific complications were as follows: neurological-recurrent stroke, epileptic seizure; infection-urinary tract infection, chest infection, others; mobility related-falls, falls with serious injury, pressure sores; thromboembolism-deep venous thrombosis, pulmonary embolism, pain-shoulder pain, other pains and psychological-depression, anxiety, emotionalism and confusion (Langhorne *et al.*, 2000). Brain abscess has also been reported as a complication of stroke (Chen *et al.*, 1995). The frequency of these complications was related to patients' dependency and duration after stroke (Langhorne *et al.*, 2000).

Late presentation of patients for physiotherapy with mobility problems >1 year after stroke showed only a transient benefit (Green *et al.*, 2002). Olaogun (1992) explained that musculoskeletal disorder, where physiotherapy is often indicated, early consultation or referral will be very beneficial among others, prevent avoidable secondary conditions.

Limb-Length Discrepancy (LLD) from various causes in both children and adults has been well documented (Inne, 1996; Stricker and Hunt, 2004). The cause of LLD can be divided into three groups: congenital (from birth), developmental from a childhood disease or injury that shows or damages the growth plates) and post traumatic (from a fracture that leads to shortening of the bone ends (SHB, 2009). Oxygen consumption and the rating of perceived exertion were observed to be increased with discrepancies >2 cm with significant increase heart rate (Gurney *et al.*, 2001). Several methods of assessing LLD had been noted (Levine, 2004; Sabharwal and Kumar, 2008). Sabharwal and Kumar (2008) claimed that clinical methods such as the use of a tape measure and standing blocks were noted as useful screening tools, but not as accurate as imaging modalities. For some time, clinicians have recognized a difference between real and apparent discrepancy (POSNA, 2009). Apparent discrepancies are basically a result of joint contractures; hip abduction results in apparent lengthening of the limb, adduction in shortening. Where, flexion contractures at the hip or knee produce apparent shortening, equinus contracture of the ankle produces apparent lengthening.

Frequent complaint by the hemiparetic patients who presented late for physiotherapy in our clinics was of a perceived shortness of the affected lower extremity. This may result from the asymmetric standing posture of the

patients with weight transference to the unaffected side. Aruin *et al.* (2000) in a compelled weight bearing-oriented program for hemiparetic patients showed that wearing a shoe lift on the non-paretic lower limb improved the asymmetrical standing posture, which resulted in lower weight imbalance. LLD as a long term complication after stroke without physiotherapy has not been adequately examined. The study aimed at finding out if LLD exists in stroke patients who present late for physiotherapy from abnormal postural nature of weight shift to the normal limb. Could there be a decreased knee Range of Motion (ROM) necessitating this? The study also aimed to ascertain this.

MATERIALS AND METHODS

Ethical approval was obtained from the research and ethic committee of Irrua Specialist Teaching Hospital, Irrua, Nigeria where, the study was done and each subject accepted it as part of their assessment routine.

Subjects: Twelve adult stroke patients (9 males, 3 females) who presented late for physiotherapy were purposefully selected for the study out. Of these, 2 were right and 10 were left hemiparetic and their age ranges from 45-78 years. The Length of Stay (LOS) before presentation for physiotherapy ranges from 3-72 months.

Exclusion criteria includes any subject with previous history of fractures, dislocation or both, arthritis, polio/other infection or deformities that could affect the knee joint or limb-length.

The following measuring instruments were used. These are:

- Weighing balance (seca, made in Germany, calibrated from 0-130). This was used to measure the weight of the patients
- An improvised stadiometer (in meters) to measure the height
- Universal goniometer to measure the knee ROM and
- A tape rule to measure the lower limb length. The true leg length measurement (i.e., anterior superior iliac spine to medial malleolus) was employed

After measuring the weight and height, each subject was asked to lie supine and the bilateral lower limb lengths were measured from the tip of the anterior superior iliac spine to the medial malleolus. The goniometer was now used to measure the bilateral knee ROM with the fulcrum placed at the tip of the medial epicondyle of the femoral bone taking into cognisance the umbilical cord and the medial malleolus as the landmarks.

This method was adopted in order not to influence the knee readings and hence, eliminate any false measurement considering the fact that the lower limbs are usually placed in external rotation about the hip joint when lying supine. The Body Mass Index (BMI) was therefore, computed using the formula: $\text{Weight Height}^{-2} (\text{kg m}^{-2})$.

Data analysis: Descriptive statistics of demographic and the associated hemiparetic variables were made. Inferential statistics of independent t-test was used to compare the paretic and non-paretic limb parameters, while the Pearson product moment correlation was used to compare the degree of knee ROM to the LLD and to the weight of the subjects, respectively.

RESULTS

Table 1 shows the calculated means of the variables. The mean age of the subjects was 63.42 ± 9.10 years. The mean weight and height were 64.12 ± 12.94 kg and 1.65 ± 0.16 m, respectively. The resultant mean BMI, was $24.18 \pm 7.64 \text{ kg m}^{-2}$. The LOS before the commencement of physiotherapy ranges from 3-72 months (mean 20.70 ± 20.30).

The associated hemiparetic variables include the paretic and non-paretic lower limb lengths, 90.50 ± 5.90 and 92.67 ± 5.76 cm, respectively with a LLD of 2.17 ± 2.86 cm; the flexion deformity (extension lag) $7.17 \pm 9.23^\circ \text{C}$ from knee ROM of the paretic, $11.25 \pm 13.64^\circ \text{C}$ and non-paretic limb, $4.25 \pm 5.74^\circ \text{C}$.

Table 2 shows the comparison of the affected and non affected lower limb variables. The limb length and the extension lag were, respectively shown not be statistically significant ($p > 0.05$).

Table 3 shows the Pearson product moment correlation of the hemiparetic variables. The correlation between body weight and BMI effect on the probable

Table 1: Demographic, limb-length, ROM and LOS variables of subjects

Subjects (n)	Variables	Mean \pm SD	Minimum	Maximum
12	Age (years)	63.42 \pm 9.100	45.00	78.000
09	Weight (Kg)	64.12 \pm 12.94	41.60	86.000
09	Height (m)	1.65 \pm 0.160	1.30	1.810
09	BMI (kg m^{-2})	24.18 \pm 7.640	15.54	42.01
12	LOS (months)	20.70 \pm 20.30	3.00	72.000
12	PLL (cm)	90.50 \pm 5.900	78.00	99.000
12	NPLL (cm)	92.67 \pm 5.760	79.00	100.000
12	LLD (cm)	2.17 \pm 2.860	-1.00	11.000
12	PKROM ($^\circ \text{C}$)	-	-	-
	0-180 $^\circ \text{C}$	11.25 \pm 13.64	0.00	40.00
12	NPKROM ($^\circ \text{C}$)	-	-	-
	0-180 $^\circ \text{C}$	4.25 \pm 5.74	0.00	15.00
12	EL ($^\circ \text{C}$)	7.17 \pm 9.23	-2.00	25.000

BMI: Body Mass Index; LOS: Length of Stay; PLL: Paretic Lower Limb; NPLL: Non-Paretic Lower Limb; LLD: Limb-Length Discrepancy; PKROM: Paretic Knee Range of Motion; NPKROM: Non-Paretic Knee Range of Motion; EL: Extension Lag

Table 2: Independent t-test analysis of lower limb length and extension lag variables

Variables	PLL	NPLL	t-value	p-value (2-tailed)
Limb length	90.50±5.90	92.67±5.76	-0.910	0.372*
Extension lag	11.25±13.64	4.25±5.74	1.638	0.116*

Values = Mean±SD; *No significant difference at $p>0.05$; PLL: Paretic Lower Limb; NPLL: Non-Paretic Lower Limb

Table 3: Correlation co-efficient between body weight and BMI; extension lag and LLD and body weight variables

Variables	r	p-value (2-tailed)
Body weight and BMI	0.566	0.091*
EL and LLD	0.675	0.016
EL and body weight	0.645	0.061*

*No significant difference at $p>0.05$; BMI: Body Mass Index; LLD: Limb-Length Discrepancy; EL: Extension Lag

body shift of the subjects showed insignificance ($p<0.05$). However, the extension lag of the knee joints when correlated with the LLD, revealed to be significant ($p>0.05$), but there was no significant difference between the extension lag and the weight of the subjects ($p>0.05$).

DISCUSSION

The LLD, which was insignificant showed that the 7 limb shortness noted in the affected limb was very minimal. Also, the weight and BMI effects on probable body weight shift, which was insignificant indicated that the body transference to the non-paretic side could also be a function of weight value that is, the more the weight, the more the shift to the weaker side of the body. Aruin *et al.* (2000) noted the asymmetrical standing posture from the lower weight imbalance and was improved by wearing a shoe lift on the non-paretic limb.

The insignificance of the extension lag, but significant when correlated with the LLD indicated that the LLD of the paretic limb was as a result of the decreased knee ROM. This also suggested that the limb-length shortness could result from the slightest degree of reduced ROM of the affected limb. The insignificance of the extension lag with the weight of the subjects implies that reduced ROM could probably be caused by hamstring-quadriceps muscle imbalance, which was enhanced by the weight transference to the opposite side. Akinpelu *et al.* (2005) showed that hamstring tightness is present in early childhood and increases with age in apparently healthy Nigerians. POSNA (2009) explained that flexion contractures at the knee (or hip) can also alter the effect of tape measurements and therefore produce apparent shortening even when made from the anterior superior iliac spine (the so called true leg length measurement).

CONCLUSION

We conclude that LLD could result as a post-stroke complication in a long neglected physiotherapy cases.

This is caused by the reduction in the Knee range of motion of the paretic limb, which may be due to probable increased hamstring-quadriceps muscle imbalance from weight transference to the non-paretic lower limb. Therefore, early physiotherapy (with quadriceps muscle exercises) of stroke patients is advised.

Since, there are several methods of assessing LLD, further studies are recommended using a more accurate and reliable methods of measurement of the LLD of the stroke patients.

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REFERENCES

- Akinpelu, A.O., U. Bakare and B.O.A. Adegoke, 2005. Influence of Age on Hamstring Tightness in Apparently healthy Nigerians. *J. Nig. Soc. Physiother.*, 115 (2): 35-41.
- Aruin, A.S., T. Hanke, G. Chaudhuri, R. Harvey and N. Rao, 2000. Compelled weight bearing in persons with hemiparesis following stroke: The effect of a lift insert and goal-directed balance exercise. *J. Rehabilitation Res. Dev.*, 37 (1): 65-72. PMID: 3031389 <http://connection.ebscohost.com/content/article/1017883882.html?sessionid=CBDA4EEEF12ACC42B54CB2CCE8431045.ehctcl>.
- Chen, S.T., L.M. Tang and L.S. Ro, 1995. Brain abscess as a complication of stroke. *Stroke*, 26: 696-698. <http://stroke.ahajournals.org/cgi/content/abstract/26/4/696>.
- Doshi, V.S., J.H. Say, S.H.Y. Young and P. Doraisamy, 2003. Complications in stroke patients: A study carried out at the rehabilitation medicine service, Changi General Hospital. *Singapore Med. J.*, 44 (12): 643-652. <http://www.sma.org.sg/smj/4412/4412a5.pdf>.
- Green *et al.*, 2002. Late physio for stroke is of minimal benefit (Physiotherapy). Paper reviewed by Mark Wallace, *Lancet*. Copyright, CMP Information Ltd. *Pulse*, 359: 199-203. http://www.accessmylibrary.com/coms2/summary_0286-25557001_ITM.
- Gurney, B., C. Mermier, R. Robergs, A. Gibson and D. Rivero, 2001. Effects of limb-length discrepancy on gait economy and lower muscle activity in older Adults. *J. Bone and Joint Surgery (American)*, 83: 907-915. <http://www.ejbs.org/cgi/content/abstract/83/6/907>.

- Inne, K., 1996. Leg length discrepancy, its causes and its importance. *Dynamic Chiropractic*, 14 (21). <http://www.chiroweb.com/mpacms/dc/article.php?id=39366>.
- Johnston, K.C., L.Y. Li, P.D. Lyden, S.K. Hanson, T.E. Feasby, R. Adams, E. Faught and E.C. Haley, 1998. Medical and neurological complications of ischemic stroke: Experience from the RANTTAS trial. RANTTAS investigators. *Stroke*, 29 (2): 447-453. PMID: 9472888. <http://www.ncbi.nlm.nih.gov/pubmed/9472888?dopt=Abstract>.
- Langhorne, P., D.J. Stott, L.J. MacDonald, L. Jones, C. McAlpine, F. Dick, G.S. Taylor and G. Murray, 2000. Medical complications after stroke: A multicenter study. *Stroke*, 31: 1223-1229. <http://stroke.ahajournals.org/cgi/content/full/31/6/1223?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=thrombosis&search>.
- Levine, D., 2004. How to Evaluate for Leg Length Discrepancy. *Podiatry Today*, 17 (6). <http://www.podiatrytoday.com/article/2698>.
- Olaogun, M.O.B., 1992. A case report on socio-economic and behavioural results of late physiotherapy in Nigeria. *J. Nig. Soc. Physiotherapy*, XI (2): 21-23.
- POSNA, 2009. Leg Length Discrepancy: Assessment and Natural History. The Pediatric Orthopaedic Soc. North America. <http://www.posna.org/education/StudyGuide/legLengthDiscrepancy.asp>.
- Sabharwal, S. and A. Kumar, 2008. Methods for Assessing Leg Length Discrepancy. *Clin. Orthopaedics and Related Res.*, 466 (12): 2910-2922. DOI: 10.1007/s11999-008-0524-9. <http://www.springerlink.com/content/k886p011231401j8>.
- SHB (Sinai Hospital of Baltimore), 2009. International Center of Limb Lengthening: Limb Length Discrepancy. <http://www.lifebridgehealth.org/sinai-body.cfm?id=1526>.
- Stricker, S.J. and T. Hunt, 2004. Evaluation of leg length discrepancy in children. CME Review Article. *Int. Pediatrics*, 19 (3): 134-146. http://int-pediatrics.org/PDF/Volume_19/19_3/134_146_ip1904.pdf.