

The Thumb Rolling Test: A Novel Variant of the Forearm Rolling Test

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ABSTRACT: *Background:* Neurologists use a variety of tests to detect subtle upper motor neuron lesion causing a mild motor impairment of the upper limb. The forearm and index finger rolling tests are some of these. Their sensitivity varies, but in general these tests appear to be more likely to be abnormal in mild motor impairment of the arm and hand due to a cortico-spinal tract lesion than tests of power, muscle tone or reflexes. Thumb rolling involves more distal limb segments than forearm rolling and distal limb segments are typically more affected than proximal limb segments after cerebral lesions to the cortico-spinal tract. *Methods:* Thumb rolling was tested, in comparison to pronator drift, forearm rolling and index finger rolling, for its sensitivity to detect a cerebral lesion of the cortico-spinal tract in 17 consecutive patients with mild pure motor stroke affecting only one arm and hand. *Results:* Thumb rolling is more sensitive (88%) than pronator drift (47%), forearm rolling (65%) and index finger rolling (65%) to detect a cerebral lesion of the cortico-spinal tract in mild pure motor stroke of the upper limb. *Conclusion:* The thumb rolling test may be a valuable adjunct clinical test to detect a subtle lesion of the cortico-spinal tract causing mild pure motor stroke of the arm and hand when the remainder of routine neurological examination is unremarkable.

RÉSUMÉ: *Le test du Thumb Rolling : une nouvelle variante du test du Forearm Rolling. Contexte :* Les neurologues utilisent différents tests pour détecter des lésions subtiles du neurone moteur supérieur causant un déficit moteur léger au niveau du membre supérieur, dont les tests du forearm and index finger rolling. Leur sensibilité varie, mais en général ces tests semblent être plus susceptibles d'être anormaux dans les cas de dysfonction légère du bras et de la main causée par une lésion du faisceau pyramidal que les tests de puissance, de tonus musculaire ou les réflexes. Le thumb rolling porte sur des segments plus distaux des membres suite à une lésion cérébrale au faisceau pyramidal. *Méthodes :* Le test du thumb rolling a été fait chez 17 patients consécutifs atteints d'un accident vasculaire cérébral moteur pur léger atteignant seulement un bras et la main, et comparé à la pronation involontaire du bras maintenu en extension, au forearm rolling et au index finger rolling. *Résultats :* Le thumb rolling est plus sensible (88%) que la pronation involontaire du bras maintenu en extension (47%), le forearm rolling (65%) et le index finger rolling (65%) pour détecter une lésion du faisceau pyramidal cérébral chez les patients porteurs d'un AVC purement moteur du membre supérieur. *Conclusion :* Le test du thumb rolling peut être un test clinique d'appoint utile pour détecter une lésion subtile du faisceau pyramidal chez les patients ayant subi un AVC avec légère atteinte motrice pure du bras et de la main quand le reste de l'examen neurologique de routine ne décèle rien de particulier.

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Neurologists prefer a variety of clinical tests to diagnose a subtle cerebral lesion of the cortico-spinal tract to the arm and hand when tests of muscle strength, muscle tone and reflexes are normal. Pronator drift is probably the most common, but a variety of tests assessing rapid alternating movements are also used. However, only a few of these tests have been tested for sensitivity and specificity to detect a lesion of the cortico-spinal tract.¹⁻⁴

The forearm rolling test was first described by Sawyer and co-workers in 1993.¹ The patient is asked to clench both fists and hold both forearms horizontally with the arms flexed in the elbow joints in a position that both wrists overlap and are vertically separated by about 5 cm. The patient is instructed to rotate rapidly both forearms around each other. In case a

unilateral brain lesion affecting the cortico-spinal tract is present, the contralesional forearm rotates slower or even remains stationary while the unaffected forearm orbits around it. A variant of the forearm rotation test is the index finger rolling test.² The index finger rolling test is performed by extending the

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index finger from the clenched fist, hold both index fingers in overlap and then rotate the fingers around each other as in the forearm rolling test. Both tests assess rapid alternating movements of more proximal muscles of the arm and shoulder.

Distal muscles of the hand and forearm comprise greater representation areas on the primary motor cortex than proximal muscles of the arm and shoulder.⁵ Based on this distal to proximal gradient of the cortico-spinal system, mild hemiparesis following focal brain lesion is typically more severe at the hand and less pronounced at proximal arm muscles.⁶ Therefore, a test assessing more distal muscles of the hand may be more sensitive to detect subtle impairments of the cerebral cortico-spinal tract when other clinical tests of muscle strength, muscle tone and reflexes are normal. In this context, the thumb rolling test described should be a valuable addendum to the forearm and index finger rolling tests.

METHODS

Patients

Seventeen consecutive subjects (five women, aged 36 to 84 years, mean age: 69 ± 14 years) with a first ischaemic or haemorrhagic mild pure motor stroke affecting only the upper limb participated. All subjects were right-handed according to a handedness questionnaire.⁷ Subjects met the following inclusion criteria: (1) presentation with a mild pure motor stroke of the arm and/or hand only (Medical Research Council Score 4-5)⁸ with the remainder of the neurological status being unremarkable, (2) normal muscle tone in the affected upper limb, (3) intact somatosensory function of the affected upper limb, (4) absence of aphasia that would interfere with the examination, (5) ability to bisect a straight horizontal line within 5% of the midpoint and

unimpaired visual fields at both eyes as measured by finger perimetry, (6) negative screening for ideomotor apraxia, (7) absence of a relevant depression or cognitive decline (8) a first ever ischaemic or haemorrhagic cerebral lesion verified by computed tomography or magnetic resonance imaging (T1-weighted, T2-weighted and FLAIR images) and (9) ability to complete the experimental protocol with the affected upper limb. Clinical details are summarized in the Table.

Study protocol

All patients underwent a detailed clinical examination by an experienced neurologist. In case a mild pure motor deficit (MRC grade 4-5)⁸ of one arm and/or hand with the remainder of the neurological status being unremarkable was documented, the experimenter, another experienced neurologist, who was naive regarding medical history, clinical, laboratory and imaging data of each patient, performed a standardized clinical examination including the following tests: (1) pronator drift, (2) forearm rolling test, (3) index finger rolling test and (4) thumb rolling test (described below). Pronator drift was tested by asking the patient to hold both forearms in supination at 90° extended forward at the shoulder joints. Patients closed their eyes after bringing the arms in position and kept their eyes closed for ten seconds. Pronator drift was documented to be pathologic in case the forearm of the affected upper limb pronated or drifted downwards within ten seconds holding the arms in supination with eyes closed. The forearm rolling¹ and index finger rolling² tests were documented to be pathologic when the forearm of the affected upper limb rotated significantly slower or even remained stationary while the unaffected forearm orbited around it. Both these tests investigate rapid alternating movements of



Figure: The patient is asked to fold the fingers of both hands with the arms flexed in the elbow joints in a position that both thumbs overlap and are vertically separated by about 1 cm. The patient is instructed to rotate rapidly both thumbs around each other.

Table: Clinical data of patients with pure motor stroke of the arm and hand

Patient	Sex, age (years)	Lesion location	Affected hand	Grade of motor paresis of the upper limb (according to the MRC)	Pronator drift	Forearm rolling test	Index finger rolling test	Thumb rolling test
1	M, 55	PC	right	4	+	+	+	+
2	M, 36	CR	right	5	-	-	-	+
3	F, 67	CR, BG	left	5	+	-	-	+
4	M, 58	pre-CG	right	5	-	-	-	+
5	M, 73	IC, BG	right	4	+	+	+	+
6	M, 45	pre-CG, CR	left	5	-	+	+	+
7	F, 66	pre-CG, CR	right	5	-	-	-	+
8	M, 82	CR	left	5	-	-	-	+
9	F, 76	IC	right	5	-	-	-	+
10	M, 77	pre-CG, CR	right	4	+	+	+	+
11	M, 78	CR	right	5	-	+	+	-
12	M, 66	pre-CG, CR	left	4	-	+	+	+
13	F, 81	IC, CR	left	5	+	+	+	+
14	M, 71	CR	left	5	-	+	+	+
15	F, 80	PC	left	5	+	+	+	-
16	M, 84	IC, CR	right	5	+	+	+	+
17	M, 76	Pre-CG	left	5	+	+	+	+

PC = pons cerebri; CR = corona radiata; BG = basal ganglia; pre-CG, precentral gyrus; IC = internal capsule; MRC = Medical Research Council; + = pathologic; - = unremarkable

more proximal muscles of the arm and shoulder. If pathologic these tests suggest a lesion of the contralateral cortico-spinal tract.^{1,2}

The thumb rolling test intended to test rapid alternating movements of both thumbs, representative of distal upper limb segments. Patients were asked to fold the fingers of both hands with the arms flexed in the elbow joints in a position that both thumbs overlap and are vertically separated by about 1 cm (Figure). Patients were instructed to rotate rapidly both thumbs around each other. The test was pathologic when the thumb of the affected arm rotated slower or even remained steady while the thumb of the unaffected upper limb orbited around it, indicative of a contralateral lesion of the cortico-spinal tract.

RESULTS

The sensitivities of the thumb rolling test, the forearm rolling test, the index finger rolling test and pronator drift to detect a unilateral lesion of the cortico-spinal tract were assessed. The pronator drift was positive in 8 out of 17 patients (47%), the forearm rolling test was positive in 11 out of 17 patients (65%), the index finger rolling test was pathologic in 11 out of 17 patients (65%) and the thumb rolling test was pathologic in 15 out of 17 patients (88%). Pathological and unremarkable results of each of the clinical tests assessed are summarized for each patient in the Table. In addition, the grade of paresis of the arm and hand is presented for each patient in the Table. Specificity could not be tested given the fact that this study was intended to investigate the differential sensitivity of a selection of clinical tests in detecting a unilateral lesion of the cortico-spinal tract in a cohort of patients already known to suffer from pure motor stroke affecting one arm and hand only.

Video 1 (videos on-line) illustrates the performance of Patient 1 with a lesion of the left cortico-spinal tract at the level of the pons cerebri during pronator drift, forearm rolling, index finger rolling and thumb rolling. All tests are pathologic at the right arm and hand. Video 2 illustrates performance of Patient 2 with a lesion of the left cortico-spinal tract just below the primary motor cortex. Only the thumb rolling test shows an asymmetry with a mild slowing of the right thumb, whereas pronator drift, forearm rolling and index finger rolling are unremarkable.

DISCUSSION

Sensitivity and specificity of the forearm and index finger rolling tests to detect a focal, unilateral lesion of the cortico-spinal tract have been investigated.¹⁻⁴ In all studies lesions of the spinal cord or peripheral nervous system were systematically excluded from data analysis. Sawyer and co-workers tested 62 adults with a radiologically confirmed lesion of the brain.¹ Asymmetric forearm rolling was the most sensitive sign of a unilateral cerebral lesion (sensitivity: 87%) with a specificity of 100%, compared to other clinical tests such as pronator drift, muscle strength, muscle tone or Babinski's sign. Yamamoto tested the sensitivity of the index finger rolling test to detect a unilateral brain lesion among 28 patients. The index finger rolling test was the most sensitive (sensitivity: 61%) compared to other clinical examinations, such as pronator drift.² Teitelbaum and colleagues found a sensitivity of 46% (specificity: 98%) of the forearm rolling test to detect a unilateral brain lesion among 170 patients.³ The forearm rolling test was more sensitive than segmental motor examination, but less sensitive than pronator drift, deep tendon reflexes or straight arm raising (Barré) test. Anderson and co-workers found a sensitivity

of 33% (specificity: 100%) for the index finger rolling test and a sensitivity of 24% (specificity: 100%) of the forearm rolling test to reveal a unilateral brain lesion in 46 consecutive patients.⁴ The index finger rolling test was the most sensitive one compared to other clinical signs, such as segmental motor examination, rapid alternating patting the thigh with the dorsum or palm of the hand, forearm rolling, pronator drift, deep tendon reflexes or Wartenberg's sign.

Given the fact that more distal muscles of the forearm and hand are typically more affected by a cerebral lesion of the cortico-spinal tract than more proximal muscles of the upper arm and shoulder,⁶ a clinical test of motor performance of the distal limb segments should be more sensitive than a test assessing motor performance of proximal limb segments in patients with pure motor stroke involving only the arm and hand. The forearm rolling test and its variant the index finger rolling test both assess rapid alternating movements of more proximal limb segments.^{1,2}

CONCLUSIONS

The preliminary data presented here suggest that the thumb rolling test may be a valuable clinical adjunct when screening for hints of a subtle impairment of the cerebral cortico-spinal tract in patients with mild pure motor stroke of the upper limb when other clinical signs and symptoms are lacking. This is most important as in these cases the conventional neurological examination (including tests of muscle strength, muscle tone and reflexes) has only a low sensitivity for detection of a focal brain lesion. The thumb rolling test appears to be more sensitive (88%) than index finger rolling (65%) or pronator drift (47%) to detect a subtle lesion of the cerebral cortico-spinal tract and takes only five to ten seconds to be performed. The thumb rolling test should be performed when a brain lesion is suspected, but routine neurological examination is unremarkable in patients with mild pure motor stroke of the arm and hand. However, more data obtained from larger study cohorts are needed to assess the true potential of this test.

NOTE

To view videos, please go to our on-line issue at www.cjns.org.

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