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ORIGINAL ARTICLE

# Patellar tendon reflex as a predictor of improving motor paralysis in complete paralysis due to cervical cord injury

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**Study design**: A retrospective study.
**Objective**: We have encountered several cases of complete sensorimotor paralysis in which patellar tendon reflex (PTR) was demonstrated approximately 3 days after injury and improvement of motor paralysis was subsequently achieved. We considered that PTR apparent in the early stage after injury may offer an index to predict improvements in motor paralysis.
**Materials and methods**: A total of 142 patients assessed as ASIA Impairment Scale A on admission from 1979 to 1998 were included in the study. The patients who demonstrated PTR within 72 h after injury were classified as the PTR(+) group and those who did not constituted the PTR(−) group. With regard to the method of motor paralysis assessment at about 6 months after injury, patients assessed as ASIA Impairment Scale A or B (that is, complete motor paralysis) were classified as 'Non-recovered', whereas those assessed as ASIA Impairment Scale C, D or E (that is, showing obvious improvement of motor paralysis) were considered as 'Recovered'.
**Results**: A significant difference was noted between groups, with the Recovered group including 16 of the 17 PTR(+) patients (94.1%) and 11 of the 115 PTR(−) patients (9.6%) ($P<0.0001$).
**Conclusion**: The results obtained indicate that motor paralysis recovery could be expected at a very high rate among patients demonstrating PTR within 72 h of injury. As all physicians should be familiar with the PTR, this seems to represent a simple and highly useful sign to predict improvements in motor paralysis during the acute stage of cervical cord injury.
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**Keywords:** spinal cord injury; cervical spine; patellar tendon reflex; motor paralysis recovery

## Introduction

Among patients with spinal cord injury in the acute phase of ASIA Impairment Scale A, patients with cervical cord injury occasionally recovered from motor paralysis, whereas almost all patients with thoracic cord injury did not.[1] Regarding cases of complete sensorimotor paralysis (Frankel A) caused by cervical cord injury, Ditunno *et al*. reported that recovery to Frankel C and D was achieved in 2.9 and 2.8% of cases,[2] respectively, indicating the possibility of motor paralysis recovery, however small the probability is. However, in cases of complete sensorimotor paralysis, no simple signs to predict recovery from motor paralysis in the early stages after injury have yet been described.

We have encountered several cases of complete sensorimotor paralysis in which PTR was demonstrated 3 days after injury and improvement of motor paralysis was subsequently achieved. Such patients were presumably neurophysiologically in a paretic state, even though they were clinically considered in a condition of complete sensorimotor paralysis. In this regard, we considered that PTR apparent in the early stage after receiving injury may offer an index to predict improvements in motor paralysis.

In general, reflex in the paralyzed region completely disappears immediately after injury in cases of complete sensorimotor paralysis due to cervical cord injury.[3,4] Superficial reflexes such as the bulbocavernosus reflex reportedly appear after several days, and deep tendon reflexes such as the PTR recover 1–2 weeks after injury.[5] As the tendon reflexes of the upper limbs are known to be affected extremely by spinal cord injury level of patients, the tendon reflexes of the lower limbs were chosen for this study.[6] Among the tendon reflexes of the lower limbs, PTR seems to be the reflex most steadily detected, whereas steady detection of Achilles tendon reflex (ATR) is difficult even in healthy persons.[7,8] Thus, although it was reported that a single clinical assessment of spasticity is a poor indication of a patient's general spasticity by Lechner *et al*.[9] and PTR

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interpretation can sometimes be challenging,[10,11] we chose PTR as the simple, reproducible and relatively objective parameter. Accordingly, we conducted a retrospective survey of patients with cervical cord injury demonstrating complete sensorimotor paralysis to investigate the relationship of PTR appearing within 72 h after injury with recovery status from motor paralysis 6 months after injury.

## Materials and methods

Among patients with cervical cord injury who were admitted to the spinal injuries center from 1979 to December 1998, a total of 233 patients were assessed as ASIA Impairment Scale A (that is, complete sensorimotor paralysis) on admission. Among these patients, 142 patients who were hospitalized within 72 h after injury and who could be followed for $\geqslant$6 months after injury were included in this study (mean age, 42.2 years; range, 7–82 years). Injuries were no-bone damage-type cervical cord injury in 32 patients, dislocation or fracture dislocation in 73 patients, flexion tear drop-type fracture dislocation in 16 patients and other injury in 21 patients. As treatment, conservative therapy was performed in all no-bone damage-type cervical cord injury cases, whereas decompression and fixation was performed in the remaining patients within 3 days after hospitalization.

During the above-mentioned period, PTR was tested almost every day for about 2 weeks from the day of admission and at 6-month follow-up. Assessment results were entered in the medical chart. Accordingly, patients who demonstrated PTR within 72 h after injury were classified as the PTR(+) group and those who did not constituted the PTR(−) group. With regard to the method of motor paralysis assessment at about 6 months after injury, patients assessed as ASIA Impairment Scale A or B (that is, complete motor paralysis) were classified as 'Non-recovered', whereas those assessed as ASIA Impairment Scale C, D or E (that is, demonstrating obvious improvement of motor paralysis) were considered as 'Recovered'. In this regard, two physicians independent of the study were in charge of ASIA Impairment Scale assessment approximately 6 months after injury on the basis of chart contents. The rate of assessment correspondence between these two physicians was favorable, at 98.6% (corresponding in 140 of 142 cases). When assessments differed, the assessment of the senior physician was adopted. To evaluate the usefulness of PTR as a sign of motor paralysis recovery, sensitivity, specificity and likelihood ratios were calculated.

## Results

The PTR(+) group comprised 17 patients and the PTR(−) group contained 125 patients. The Recovered group included 27 patients, while the Non-recovered group comprised 115 patients (Table 1). Regarding the number of patients classified as Recovered, a significant difference was noted between groups, with the Recovered group including 16 of the 17 PTR(+) patients (94.1%) and 11 of the 115 PTR(−) patients (9.6%) ($P<0.0001$). Sensitivity, specificity and likelihood ratios were 94.1, 99.1 and 165.818% (95% confidence interval, 20.045–1371.715), respectively.

**Table 1** Relationship between PTR appearing and motor recovery status

| | *Recovered group* | *Non-recovered group* |
|---|---|---|
| PTR(+) group | 16 cases | 1 cases |
| PTR(–) group | 11 cases | 114 cases |

The likelihood ratio: 16.58 (95% confidence level: 20.04–1371.71).
Sensitivity: 94.1%, specificity: 99.1%.

At 6-month follow-up, the changes in tendon reflex were observed: Among 17 PTR(+) patients, all patients were PTR-positive; among 11 PTR(−) patients in the Recovered group, 2 were PTR-negative, 9 PTR-positive; among 114 PTR(−) patients in the Non-recovered group, 28 were PTR-negative, 86 PTR-positive. In the comparison among groups, the difference between PTR(+) group, PTR(−) patients in the Recovered group, and PTR(−) patients in the Non-recovered group was not statistically significant.

Regarding the period of recovery from motor paralysis, of 16 PTR(+) patients in the Recovered group, 5 recovered within 1 week, 8 between 1 and 8 weeks, and 3 over 8 weeks, whereas of 11 PTR(−) patients in the Recovered group, 2 recovered within 1 week, 7 between 1 to 8 weeks and 2 over 8 weeks; the difference between the two groups was not statistically significant. The recovery of sensation within 1 week after injury was observed only in 7 patients who recovered from motor paralysis within 1 week. Regarding 27 patients in the Recovered group, 13 were evaluated as ASIA Impairment Scale C, 11 as Scale D and 3 as Scale E at 6 months after injury; the difference between the PTR(+) group and PTR(−) group was not statistically significant.

## Discussion

Various methods have been described to predict improvements in motor paralysis immediately after injury in patients with complete sensorimotor paralysis due to cervical cord injury, including the use of hematoma size on magnetic resonance imaging,[12–14] somatosensory evoked potentials[15–18] and determination of amplitude in electromyography.[19,20] However, none of these methods are simple. Ko *et al*.[5] reported that recovery from motor paralysis is less likely in patients who demonstrate delayed plantar reflex (DPR) in the initial stages of injury. However, DPR is a pathological reflex that is not well known and delicate assessment is often necessary.[21] We also assessed BCR representing the superficial reflex. As a result, BCR within 72 h after injury was positive in 67 (47%) of 142 patients in this study and 19 (28%) of the 67 patients showed improvement in paralysis. Meanwhile, BCR within 72 h after injury was negative in 75 of the 142 patients and 8 (11%) of the 75 patients showed the improvement in paralysis. These results indicate that within 72 h after injury BCR-positive patients tend to have improved motor paralysis more frequently than BCR-negative patients. As we presumed that PTR can be measured

stably as compared with other reflexes mentioned in the Introduction section, we presented only the results of PTR to make the point of this study clear.

The results obtained in this study indicate that motor paralysis recovery could be expected at a very high rate among patients demonstrating PTR within 72 h after receiving injury. As all physicians should be familiar with the PTR, this seems to represent a simple and highly useful sign to predict improvements in motor paralysis during the acute stage of cervical cord injury.

## Conclusion

Among 142 patients with complete sensorimotor paralysis (ASIA Impairment Scale A) due to cervical cord injury, improvements in motor paralysis were observed at a high rate (94.1%) 6 months after injury in patients demonstrating PTR within 72 h after injury. On the basis of this result, PTR appears to offer a simple and useful sign to predict improvements in motor paralysis in the acute stage of cervical cord injury.

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