수면다원검사의 움직임 규칙

김 지 영
부산의대 신경과학교실

Movement rule

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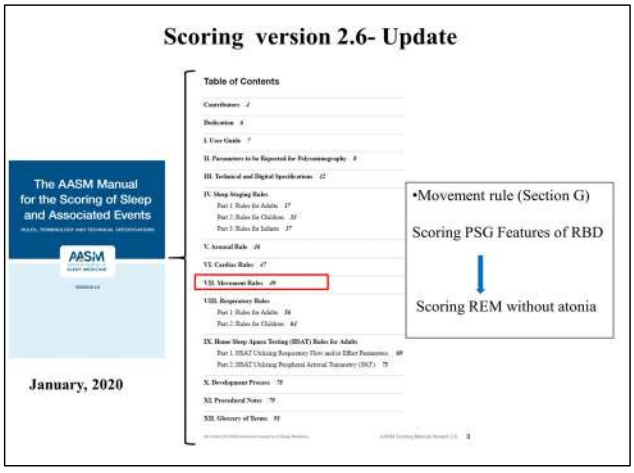
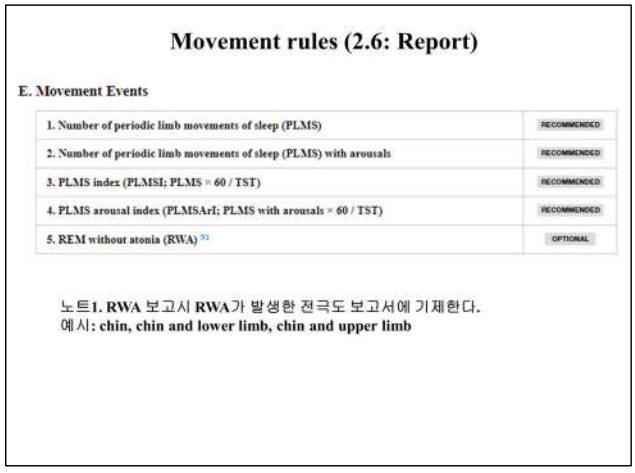
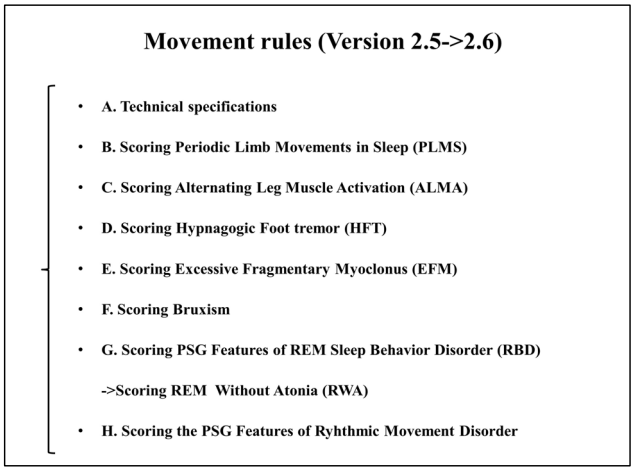
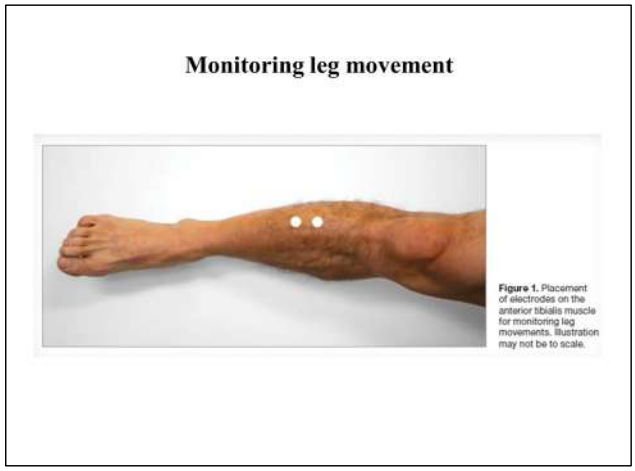


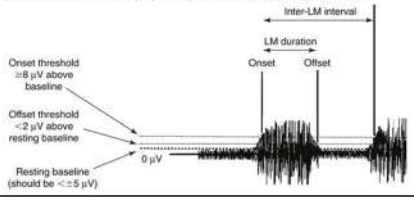


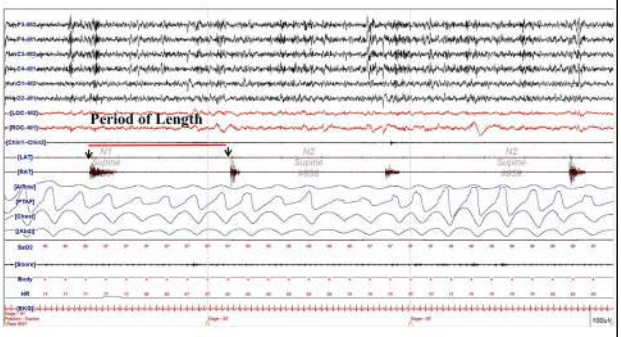




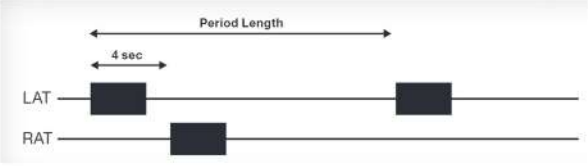
Scoring Periodic Limb Movements in Sleep (PLMS)

1. Define a significant **Leg movement(LM)**
   a. The **minimum** duration of a LM event is **0.5** seconds
   b. The **maximum** duration of a LM event is **10** seconds
   c. The minimum amplitude of a LM event is an **8μV** increase in EMG voltage above resting EMG **(duration of at least 0.5seconds)**
   d. The timing onset of the onset of a LM event is defined as the point at which there is an **8μV** increase in EMG voltage above resting EMG
   e. The timing of the ending of a LM event is defined as the start of a period lasting at least **0.5** seconds during which EMG does not exceed **2μV** above resting EMG.



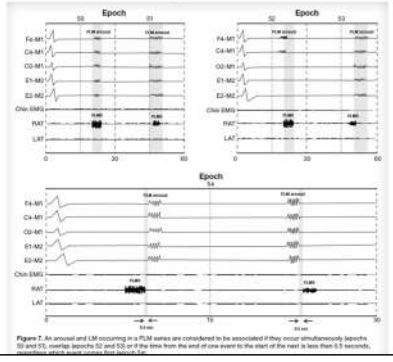


2. Define a **PLM series**
   a. The **minimum** number of consecutive LM events needed to define a PLM series is **4LMs**
   b. The **period of length** between LMs (defined as the time between onsets of consecutive LMs) to include them as part of a PLM series is **5 to 90** seconds.
   c. Leg movements on 2 different legs separated by **less than 5 seconds** between movement onsets are counted as a **single leg movement**. The **period length** to the next LM following this group of LMs is measured from the onset of the **first LM** to the onset of **the next**.



양쪽 하지의 근전도에서 관찰된 처음 2개의 LMs은 5초 미만의 간격을 두고 있어 1개로 간주하고, 각 LM 사이의 간격(Period length)은 첫번째 LM과 3번째 LM의 시작을 기준으로한다.

3. **PLM associated arousals**
An arousal and a limb movement that occur in a PLM series should be considered associated with each other if they occur **simultaneously, overlap, or when there is < 0.5 Secs** between the end of one event and the onset of the other event regardless of which is first.



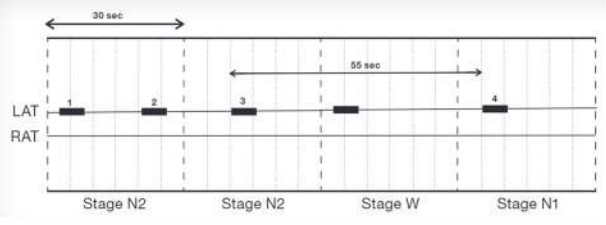
4. LM and breathing events

2007 년
-> An LM should not be scored if it occurs during a period from 0.5 seconds preceding an apnea or hypopnea to 0.5 seconds following an apnea or hypopnea

2012 년 (V 2.0)
-> An LM should not be scored if it occurs during a period from 0.5 seconds preceding an apnea or hypopnea , RERA or sleep-disordered-breathing event to 0.5 seconds following an apnea or hypopnea

2017 년 (V 2.4)
-> An LM should not be scored if it occurs during a period from 0.5 seconds preceding an apnea or hypopnea , RERA or [redacted] 0.5 seconds following an apnea or hypopnea

5. PLM series and wake



PLMS를 계산할 때 중간에 Waking 이 있어도 Waking이 90초 미만으로 period length 기준을 만족하면 Waking보다 선행하는 LM을 포함하여 같은 PLMS series로 간주한다. 즉 그림에서 5개의 LM이 있으나 4번째 waking에 있는 LM은 PLM 수로 포함하여 계산하지 않는다. 나머지 4개의 LM만 동일한 PLM series에 있는 PLM 수로 포함하여 계산한다.

•Note 1. Limb movement에 사용된 근전도 진폭의 정의는 안정기 상태(resting EMG) 에서 근전도 진폭이 10 μV를 넘어서 얻어진 게 아니어야 한다.

•Note 2.Periodic Limb Movements(PLM) 가 10초 미만 간격으로 일어나고, 각각의 PLM이 각성을 동반한다면 처음 동반되는 각성만 PLM과 관련된 각성으로 간주한다. 그러나 2개의 LM은 5초 이상 간격을 두고 발생하였다면 2개로 간주한다.

Scoring Alternating Leg Muscle activation(ALMA)-optional

- ALMA must have at least 4 muscle burst
- The minimum ALMA frequency is 0.5Hz
- The maximum ALMA frequency is 3.0Hz

Note 1. ALMAs alternating between legs
Note 2. The usual range for duration of ALMA is 100-500 msec.
Note3. ALMA may simply be a benign movement phenomenon associated with characteristics EMG patterns as there have been no reported clinical consequences.

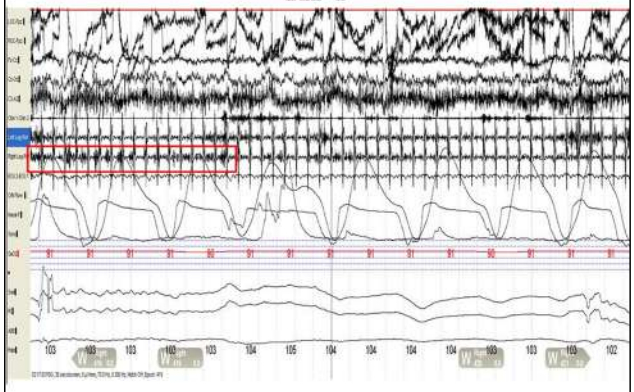
Scoring Hypnagogic Foot Tremor(HFT) -optional

- HFT must have at least 4 muscle burst.
- The minimum HFT frequency is 0.5Hz
- The maximum HFT frequency is 4.0Hz

Note1. The usual range for duration of hypnogogic foot tremor is 250-1,000msec.

Note2. HFT may simply be a benign movement phenomenon associated with characteristic EMG patterns as there have been no reported clinical consequences.

HFT



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Scoring Excessive Fragmentary Myoclonus (EFM)-optional

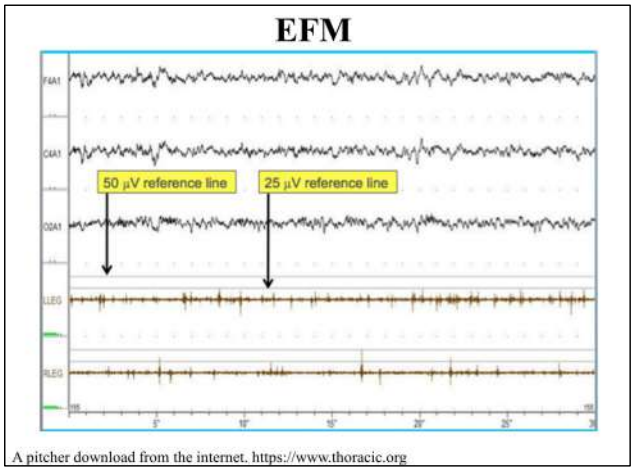
- EMG burst last less than 150 msec
- At least 20 minutes of NREM sleep with EFM must be recorded.
- At least 5 EMG potentials per minute be recorded.

Note1. EFM may be a benign movement phenomenon associated with a characteristic EMG pattern as there have been no reported clinical consequences

Note2. **In many cases no visible** movements are present. Gross, Jerk-like movements across the joint spaces are not observed. When minor movements across a joint space is present, the movement resembles the small twich like movements of the fingers, toes, and the corned of the mouth intermttenrly seen in REM sleep in normal individuals.

Note3. In some cases when visible movement is present, the EMG burst duration may be >150 msec.

EFM



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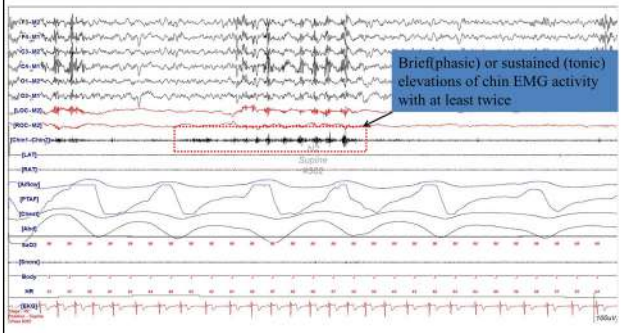
Scoring Bruxism

- Brief(phasic) or sustained (tonic) elevations of chin EMG activity with **at least twice** the amplitude of background EMG
- **Brief elevation** o f **chin or masseter EMG**: **0.25-2seconds** in duration, at least 3 in a regular sequences
- **Sustained elevations** of **chin or masseter EMG** >**2sec**
- **At least 3seconds** of stable background chin EMG before a new episode of bruxism
- Can be scored reliably by audio in combination with PSG by a minimum 2audible tooth grinding episodes/ night of PSG in the absence of epilepsy

Masseter muscle for detecting bruxism

Figure 4. Placement of electrodes on the masseter muscle for detecting bruxism. Illustration may not be to scale.

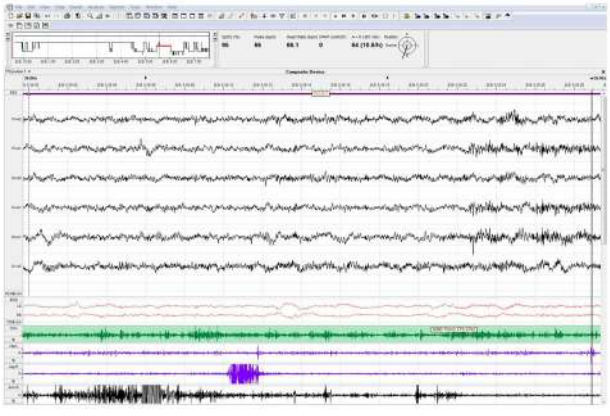
Bruxism



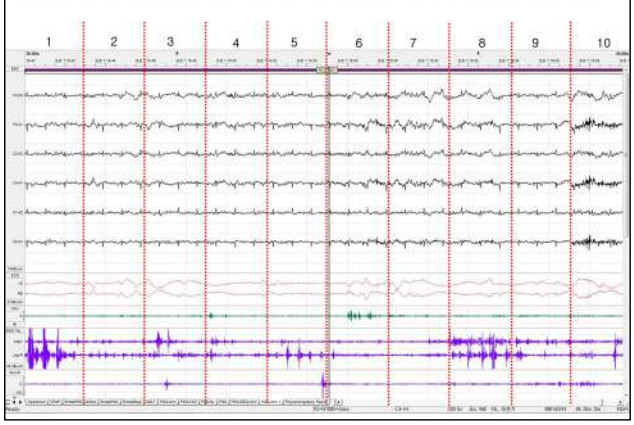
Scoring REM Without Atonia (RWA) : Version 2.5

- **Sustained muscle activity (tonic activity) in REM sleep**
  : Chin
  at least **50% of the duration** of the epoch having a chin EMG amplitude **greater than the minimum amplitude of NREM**
- **Excessive transient muscle activity (phasic activity) in REM sleep**
  : Chin and limb
  at least 5(50%) of the mini-epochs contains bursts of transient muscle activity.
  Excessive transient muscle activity **bursts are 0.1-5 seconds** and **at least 4 times** as high in amplitude as the background EMG activity

Sustained muscle activity (tonic activity) in REM sleep



Excessive transient muscle activity (phasic activity) in REM sleep:



Scoring REM Without Atonia (RWA) : **Version 2.6**

- **Sustained muscle activity (tonic activity) in REM sleep**
  : Chin
  at least **50% of the duration** of the epoch having a chin EMG amplitude **at least two times greater than the stage of R atonia** level (or **lowest amplitude in NREM**, if no stage of R atonia is present). **Multiple segments** may contribute to the **total** duration , but **each segment** must be **greater than 5seconds**

- **Excessive transient muscle activity (phasic activity) in REM sleep**
  : Chin and limb
  at least 5(50%) of the mini-epochs contains bursts of transient muscle activity. Excessive transient muscle activity **bursts are 0.1-5 Secs** and amplitude **at least two times greater than the stage of R atonia** level (or **lowest amplitude in NREM**, if no stage of R atonia is present)

- **Any chin EMG activity**
  activity with a minimum amplitude two times greater than the stage of R atonia level (or **lowest amplitude in NREM**, if no stage of R atonia is present) **without regard duration** activity **(including burst of 5~15 Secs)**

Scoring REM Without Atonia (RWA) : **Version 2.6**

- **Sustained muscle activity (tonic activity)** in REM sleep in chin EMG (recommended)
- **Excessive transient muscle activity (phasic activity)** in REM sleep in chin and limb EMG(recommended)
- **At least 50% of 3 secs mini-epochs** contain **any chin activity** (defined as in rule **any chin EMG activity**) or **limb activity** (burst of EMG activity 0.1-5secs in duration and amplitude at least two times greater than the stage of R atonia level or lowest amplitude in NREM, if no stage of R atonia is present) **(acceptable)**

Scoring RWA index as the % of stage R epochs : **Version 2.6**

- optional

• Note 1. The definition of sustained and transient muscle activity are based on duration rather than morphology.

•Note 2. If a PLM is scored as part of a PLM series, it should not be counted in determining if an epoch has RWA

•Note 3. Based on SINBAR Group recommend in criteria; Sleep 2012;25(6):835-847

•Note 4. Epoch containing RWA with sustained chin activity as defined above may not meet criteria for R, but in these case, the epoch can still be scored as stage R if other criteria for stage R are met or if the epoch is contiguous with an epoch scored as stage R.

•Note 5. If electing to measure RWA, the leads used to determine the presence of RWA should be included in the PSG report(e.g., chin, chin and limb, chin and upper limb)

RWA index in PNUH

Table 3. Comparison of RSWA proportion between RBD and controls

Variables	Total data set			Data set by PSM		
	RBD (n=19)	Controls (n=23)	p	RBD (n=14)	Controls (n=14)	p
Tonic activity*, %	11.7 (3.2–13.6)	3.8 (1.7–4.7)	<0.001	12.0 (5.0–20.1)	4.0 (1.3–4.9)	0.001
	12.5±9.6	3.6±2.6		14.2±10.4	3.8±3.1	
Phasic activity*, %	4.4 (2.4–9.9)	2.2 (1.6–3.2)	0.017	3.8 (2.3–9.5)	2.0 (1.5–3.3)	0.039
	6.3±5.0	2.5±1.1		6.7±5.9	2.0±1.3	
RSWA*, %	14.8 (9.6–23.0)	5.7 (4.1–7.2)	<0.001	16.5 (8.8–24.6)	6.3 (4.1–7.2)	0.001
	19.0±14.9	5.9±2.8		20.8±16.3	6.0±3.6	

*variables are analyzed by Mann–Whitney U test and shown as a median (interquartile range). RSWA: REM sleep without atonia, RBD: REM sleep behavior disorder, REM: rapid eye movement, PSM: propensity score matching.

•**Chin and leg EMG**

•**Version 2.4**

•**RWA index: (RSWA epoch/total REM epoch)*100**

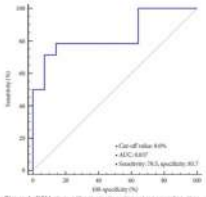


Figure 1. REM sleep without atonia and receiver operating characteristic curve in diagnosis of REM sleep behavior disorder. REM: rapid eye movement, AUC: area under the curve.

J Sleep Med 2020;17(1):31-36

Flexor digitorum superficialis

Figure 2. Placement of electrodes on the flexor digitorum superficialis for detecting transient muscle activity in REM sleep. Illustration may not be to scale.

Extensor digitorum communis

Figure 3. Placement of electrodes on the extensor digitorum communis for detecting transient muscle activity in REM sleep. Illustration may not be to scale.

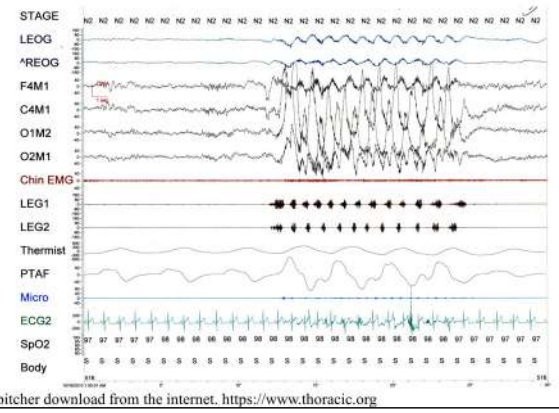
Scoring the PSG Features of Rhythmic Movement Disorder

- The minimum frequency for scoring is 0.5Hz
- The maximum frequency for scoring 2.0Hz
- The minimum number required for a cluster or rhythmic movement: 4
- The minimum amplitude : 2times the background EMG activity

Scoring the PSG Features of Rhythmic Movement Disorder

Rhythmic movement disorder 평가 시 paraspinal muscle에 부착하는 전극의 위치

Sleep-related Rhythmic Movement Disorder (SRMD)



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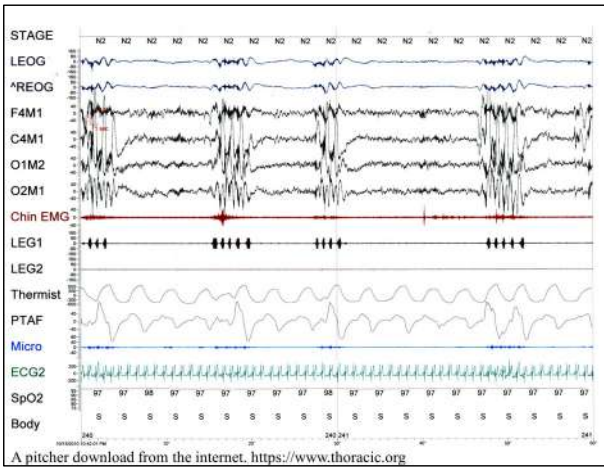

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정리

1. **Movement rule**은 이전과 비교하여 version 2.5에서 **any chin EMG activity & RWA**의 **정량화**에 대한 내용이 추가 되었다.

2. **Movement rule**에 나와 있는 event는 수면다원검사후 **비디오 영상**이나 **소리** 확인이 필요하다.