

# Registration of jaw movements



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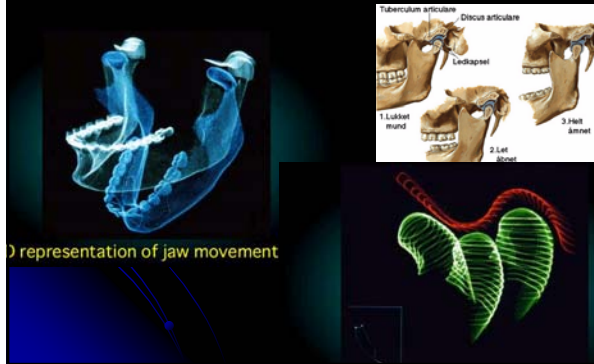
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## Composite of several movements



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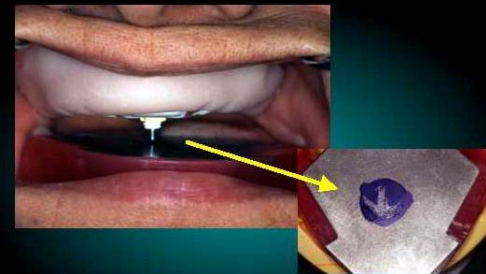
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## Methods – palatal stylus tracing



<1900 – 2 degrees of freedom (xy) "Gothic arch"

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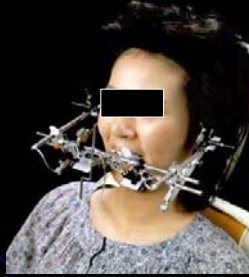
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## Methods – pantograph



1950 - 2 degrees of freedom

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## Methods – Kinesiograph MKG



Jankelson, 1975 – 3 degrees of freedom

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## Methods – optical tracing



Selspot, 1975 - 3 degrees of freedom ,  
contact free --- Qualisys, 1990

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## Methods – ultrasound



1990 - 3 degrees of freedom

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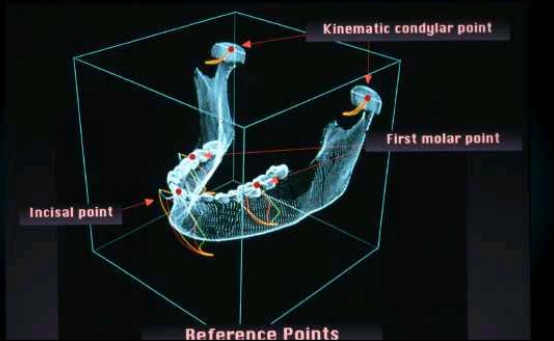
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## 6 degrees of freedom



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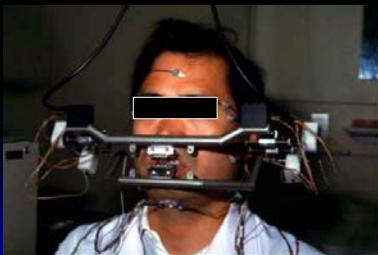
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## Methods – magnet tracing



Sirognatograph 1995 - 3 degrees of freedom -> 6

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**1. Which jaw tracking systems have been used**

Methods	(n reports)
Selspot	(25)
Kinesiograph	(18)
Sirognathograph	(17)
Visiotrainer	( 8)
other (e.g. 3DJaws)	(30)

2-degrees of freedom  
3-degrees of freedom  
6-degrees of freedom

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**2. Which functions has been evaluated in studies?**

Function	(n reports)
Test food chewing	(72)
Chewing imitation	(11)
Opening-closing	(10)
Closing from PIOS (Postural inter-occlusal space)	( 6)
Border movements	(12)

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## Aims of studies

### 1. Basic research

- Neurological mechanisms – age, gender, tooth loss, experiments, etc.
- Chewing effectiveness
  - Diet – consistency, softness, size, weight, etc.

### 2. Therapy

#### - Diagnostic purpose

- Control patients vs. – TMD, malocclusion, prostheses, implant-ret.
- Malocclusion

#### - Interventions - results

- TMD - splints, occlusal equilibration
- Surgery – ortognathic, joint- & discectomi
- Prosthodontics – prostheses, implants, FPDs
- Pharmacology – Parkinson

### 3. Test of methodologies

- Validity, reliability, repeatability, measurement error, CV

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## Should jaw tracking be used for diagnosing TMD patients?

### Common signs & symptoms are

- limited opening,
- deviation on opening
- complaints about chewing ability
- The initial answer would initially appear to be positive.

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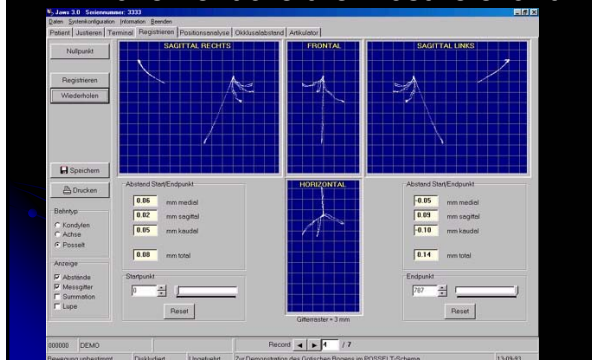
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## TMD - Which parametres for jaw movement are the most relevant?




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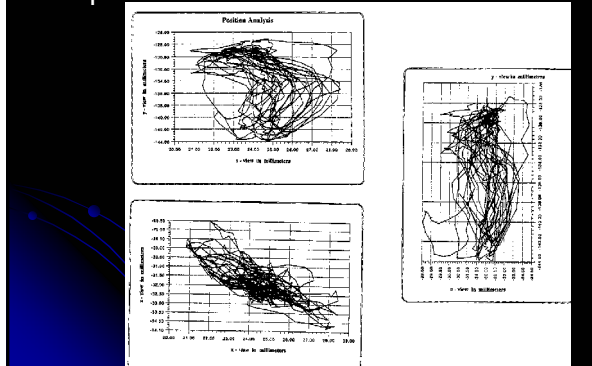
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# Which parametres?

## 1. Displacement




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## 1. Displacement - reported criteria

- Spatial (-xyz) -Open close (mm)
- Frontal/sagittal/horizontal plane
  - Vertical location at turnpoint (mm)
  - Approach/departure angle -Open, close (degrees)
  - Open-close trajectory:
    - width (mm)
    - amplitude  $Sq(x^2+y^2)$  (mm)
    - "core area" (mm<sup>2</sup>)
    - areas relative to defined axis (mm<sup>2</sup>)
    - envelope area (mm<sup>2</sup>)
  - Border limits relative to ICP (mm)
  - Jaw location at max. velocity -Open, close (mm)
  - Ratios: left-right("laterality index"), vertical- horizontal- sagittal axes, chewing location: border limits

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## Studies

- Max. vertical amplitude
  - \* + Feine&Lund95, Kuwahara ea, 94, ...
- Width of envelope
  - Kuwahara ea, 94
- Distance open phase\*
- Distance close phase\*
- Distance lateral\*
- \*Jemt ea, 79, Jemt&Karlsson80, Jemt 81, Jemt&Hedegård82ab, Jemt ea, 82, Jemt&Karlsson82, Jemt ea 83, Jemt&Olsson84, Jemt ea, 85, Jemt&Stålblad,86, Karlsson&Carlsson89, Karlsson&Carlsson90, Kiliaridis ea91, Karlsson&Jemt91, Tzakis ea, 92, Karlsson ea, 92ab, Book ea, 92, Jemt ea, 93, Kjellberg ea, 95

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## Displacement

Study aim	Significant differences (n)				No differences (n)			
	Spa- Fro- Sag- Hor	Spa- Fro- Sag- Hor	Spa- Fro- Sag- Hor	Spa- Fro- Sag- Hor				
Methodology	2	3	2	2	0	1	0	6
Food type	0	6	2	4	1	3	2	3
Basal mechanism	5	4	0	2	2	0	0	2
Diagnostic purpose	3	7	1	7	0	3	4	0
Treatment outcome	3	5	1	6	2	2	2	7

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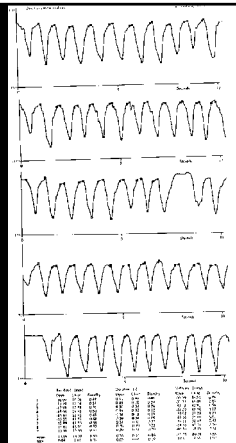
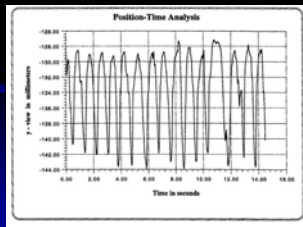
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## Which parametres?

1. Displacement
2. Time




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## 2. Time, full cycle, open-, close-, occlusion phases

Study aim	Significant differences (n)				No differences (n)			
	full	open	clos	occl	full	open	clos	occl
Methodology	0	2	0	0	3	1	4	3
Basal mechanism	3	2	2	2	5	4	3	4
Food type	8	2	3	3	1	3	3	2
Diagnostic purpose	3	5	5	0	2	1	3	1
Treatment outcome	4	3	3	4	7	10	9	8

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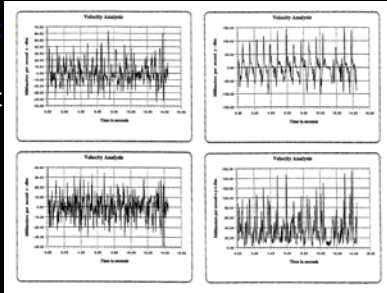
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## Which parameters?

1. Displacement
2. Time
3. Displacement /time, i.e. velocity




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## 3. Velocity- reported criteria

- Opening - Closing phase
  - Mean, maximum
  - Ratio opening:closing phase
  - Maximum relative to:
    - turnpoint (%) (mm)
    - ICP (mm)
    - time
  - Decrease followed by increase < 3mm/s
  - Patterns: "swing", uni/bimodal-flat, smooth/irregular

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## Velocity

Study aim	Significant differences (n)		No differences (n)	
	open	close	open	close
Methodology	5	4	0	1
Food type	6	6	0	1
Basal mechanism	3	4	2	2
Diagnostic purpose	5	8	4	3
Treatment outcome	12	7	4	6

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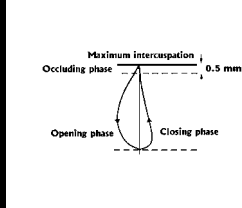
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## Hvilke parametre?

1. Displacement
2. Time
3. Displacement/time, i.e. velocity
4. Pattern recognition /classification  
e.g. chewing




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## 4. Pattern recognition

### Patterns described in studies:

	2	3	4	6	7	12	14
<u>Plane</u>							
Frontal:	7	1	3	1	1	1	1*
Sagittal:	4	5	2				
Horisontal:	1		1				

\*14open x 14close patterns grouped into 9 main groups

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## Jaw movement- TMD patients

- Amplitude of movement in vertical, horizontal, and anteroposterior directions
  - no chewing
  - Chewing
- Reproducibility or consistency of movement
  - no chewing
  - chewing (pattern)
- Velocity
  - no chewing
  - chewing
- Vertical freeway space

Soboleva U, Jokstad A, Eckersberg T, Dahl BL. Chewing movements in TMD patients and a control group before and after use of a stabilization splint. Int J Prosthodont 1998;11:158-64

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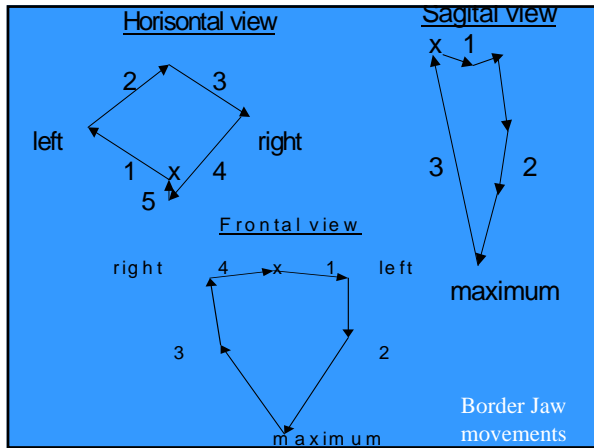
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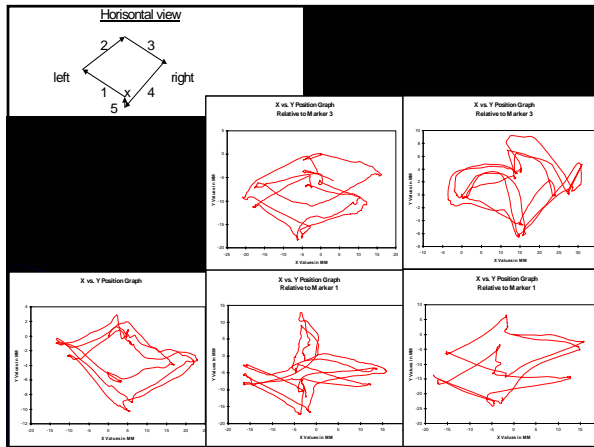
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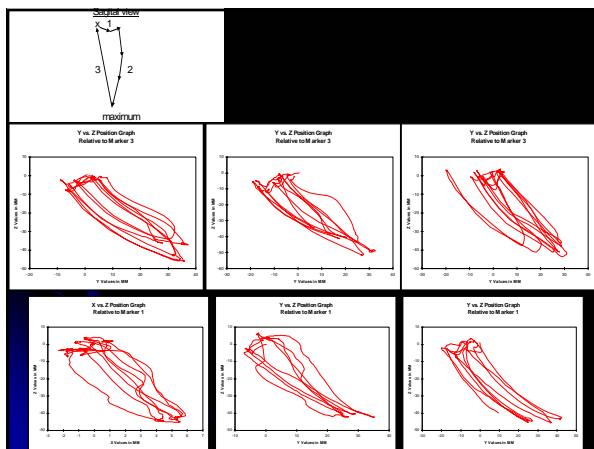
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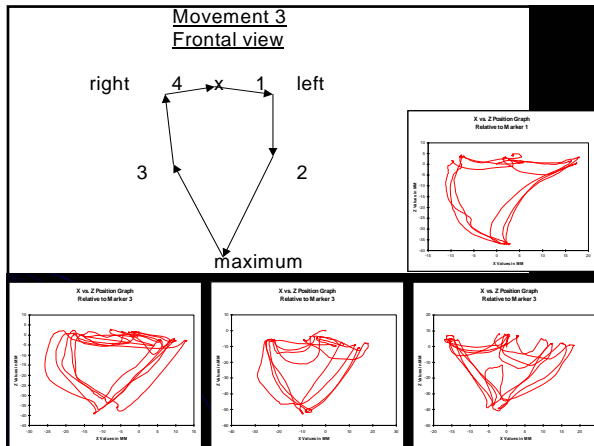
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- ### Other parametres?
1. Displacement
  2. Time
  3. Displacement/time, i.e. velocity
  4. Pattern recognition/classification
  5. Other:
    - Rotation (degrees)
    - Acceleration (mm/s<sup>2</sup>)
    - Closest speaking space (mm)
    - Postural inter-occlusal space (PIOS) (mm)
    - Chewing preference side (%)
    - Torque (degrees)

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### Conclusions-1

There is a great variation in choice of criteria to describe aspects of jaw movements, as well as different recording apparatus.

The variation in study designs complicates valid comparisons of reported values of jaw movement during function.

The duration of the full and phasic parts of the cycles is only affected by food type and under some experimental conditions.

The duration seems to be less influenced by experimental and demographic variables compared to the effects on displacement and velocity of the jaw.

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## Conclusions -2

Only recent studies present jaw movement data based on 6 degrees of freedom, i.e. the jaw posture during movements

There is a marked variation in reported significant effects of different demographic and experimental variables on chewing parameters

Both Type I (alfa) and Type II (Beta) errors are probably present among many studies reporting jaw movement

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## Should jaw tracking be used for diagnosing TMD patients.?

Common signs & symptoms are

- limited opening,
- deviation on opening
- complaints about chewing ability
  
- The initial answer would appear to be positive.
- Does the dentist gain diagnostically additional relevant information from jaw tracking?
- This is an important question in view of the sparse and mostly unreplicated scientific evidence linking jaw motion to TMD diagnosis.

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