Supporto strumentale alla medicina posturale
Novaggio 2019

ToB
Test of Balance

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Sistema posturale e controllo dell'equilibrio

Come riesce un uomo a mantenere una postura eretta o inclinata contro il vento che soffia contro di lui?
Egli possiede un senso attraverso il quale conosce l'inclinazione del proprio corpo e che possiede l'attitudine ad aggiustarla e correggere ogni scarto in rapporto alla verticale…

Charles Bell 1837

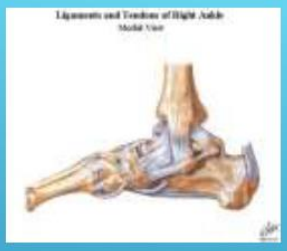
Integrazione di più sistemi:

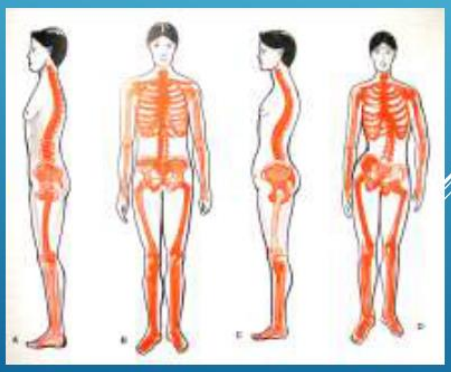
Esoentrate

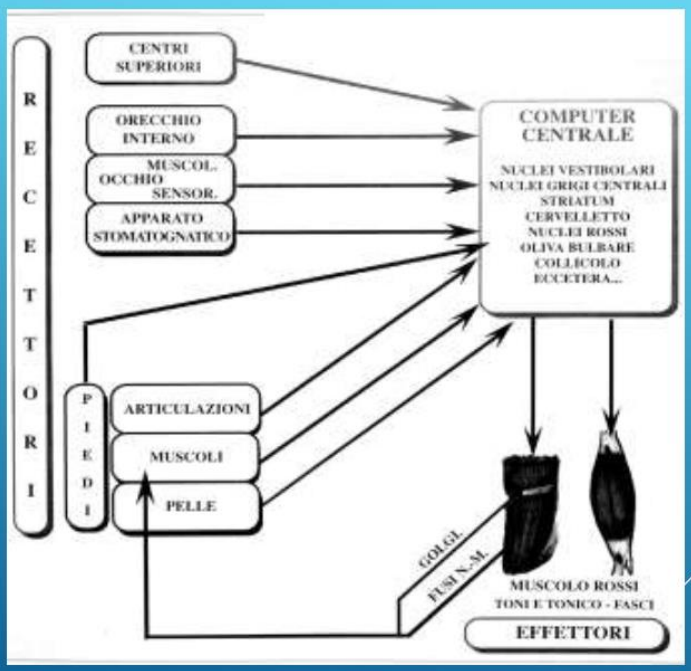
Occhio
Vestibolo
Sensibilità tattile

Endoentrate

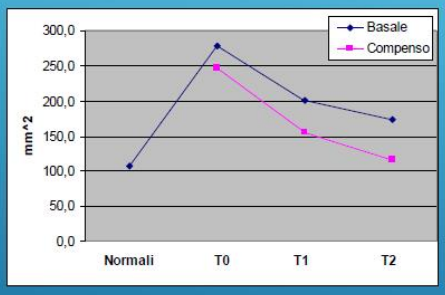
Recettori articolari
Recettori tendinei e muscolari





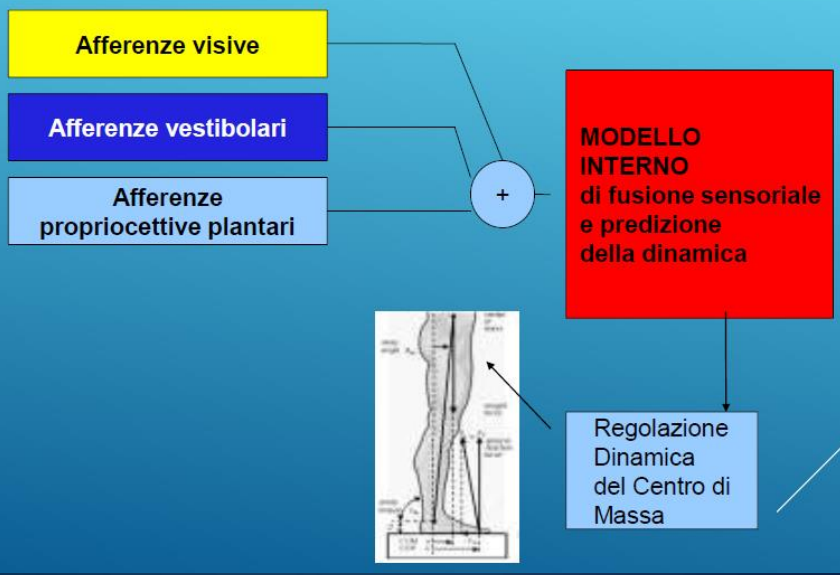


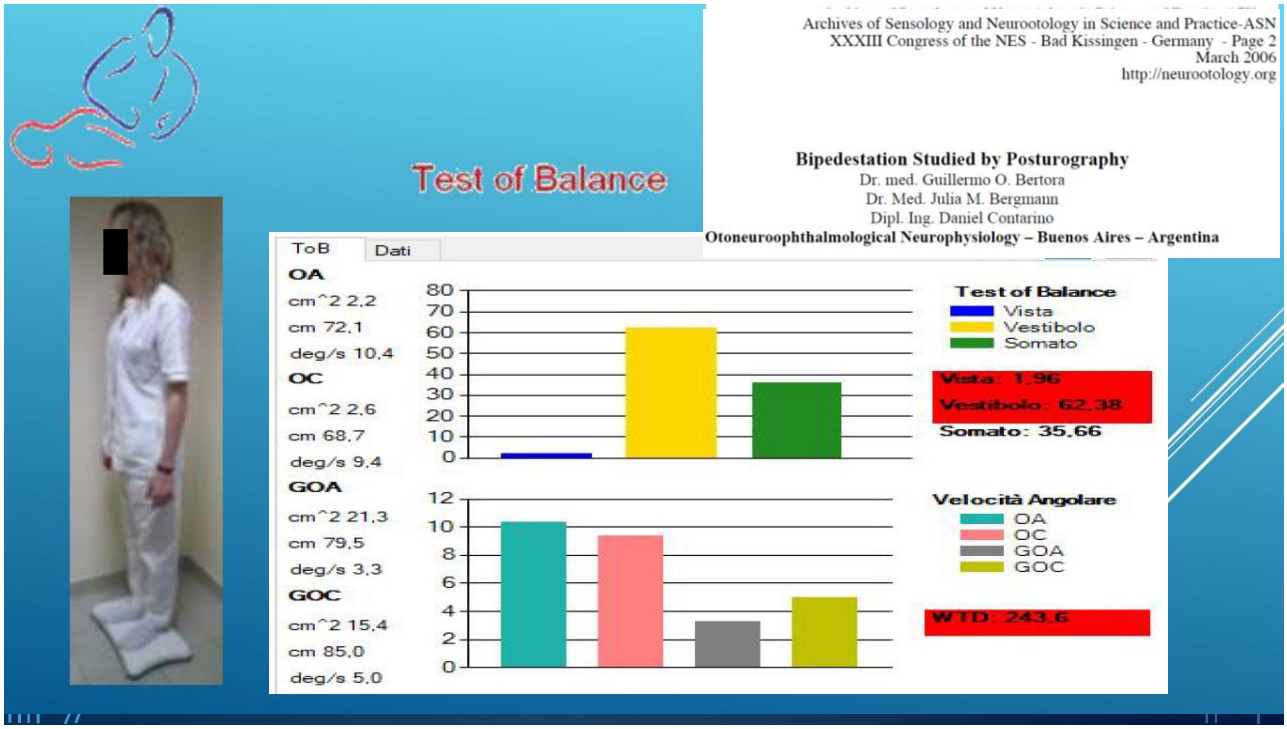
Valutazione Stabilometrica: Area dello SKG



	Media basale		
Normali	T0	T1	T2
107,7	278,6	200,9	173,8
	Media - compenso		
	T0	T1	T2
	246,5	155,3	116,7
Test T	T0 e T0	T1 e T1	T2 e T2
	0,196658	0,077628	0,017277

Test di organizzazione sensoriale
Test of Balance (Bertora et al, 2006)





About Balance on Platform: Mathematical Modeling for Clinical Evaluation

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At the end of each test, the software also evaluates the **predominant direction** of the movement (angle in deg), the **area (A)** of the COG's projection in cm_ and the **total displacement (TD)** or length (in cm) of the COG's projection path. Several relationships are calculated from these parameters.

The four patient's condition that define each 30 second test are:

- **Test 1:** Eyes open, stable surface **(EOS)** : complete equilibrium information
- **Test 2:** Eyes closed, stable surface **(ECS)** : somatosensory and vestibular information
- **Test 3:** Eyes open, unstable surface **(EOU)** : visual and vestibular information
- **Test 4:** Eyes closed, unstable surface **(ECU)** : vestibular information only

The unstable condition (tactile information suppressed or very attenuated) is performed using a thick foam cushion over the platform.

4. Mathematical analysis

Let us assume that **TD** (Total Displacement in cm), **A** (Area of equilibrium in cm^2) and **V** (mean COG's velocity in deg/s) **inversely** describe the patient's ability to maintain an equilibrated or stable position over the time.

The patient's stabilitity coefficients $\mathbf{S_n}$ are calculated as $S_n = \frac{1}{\sqrt[3]{TD_n * A_n * V_n}}$, where n is the test number. The idea is combining the three **instability** parameters (TD, A and V), minimizing possible errors or artifacts in the measure process, usually seen in software that use only one parameter for the calculations.

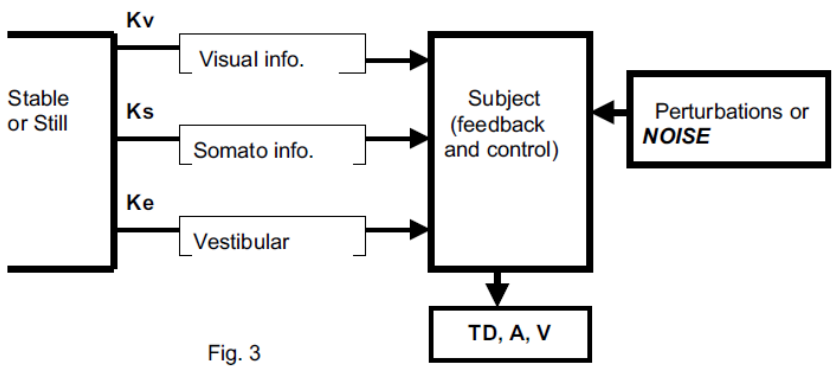

Fig. 3

Let us assume that **Kv**, **Ke** and **Ks** are the contributions of each mechanism (visual, vestibular and somatosensitive) to the patient's stability, and **Sn** the stability in test **n** (n=1 to 4). Making some simplifications, concerning to the different frequency response of the equilibrium control systems, we can write:

(1) $Ks + Kv + Ke = S_1$ condition in test 1 (all system working)

(2) $Ks + ___ + Ke = S_2$ condition in test 2 (no visual information)

(3) $Kv + Ke = S_3$ condition in test 3 (no somato info)

(4) $Ke = S_4$ condition in test 4 (only vestibular info)

Introducing (4) in (1), (2) and (3) we get:

(5) $Ks + Kv = S_1 - S_4$

(6) $Ks = S_2 - S_4$

$Kv = S_3 - S_4$ or introducing (6) in (5) we get

(7) $Kv \cup S_3 - S_4 \cup S_1 - S_2$

This double result for **Kv** is produced because we have four equations (tests) and only three variables. Different tests demonstrate that (7) is exact within less than 10%. We can assume **Kv** as the average between both solutions:

(8) $Kv = (S_3 - S_4 + S_1 - S_2)/2$

We refer each contribution to the sum of (8), (6) and (4) , which is $(S_3 - S_4 + S_1 + S_2)/2$ and speaking about percentages:

$Pv = \frac{(S_3 - S_4 + S_1 - S_2)}{(S_3 - S_4 + S_1 + S_2)} * 100\%$ visual contribution to stability

$Ps = \frac{2*(S_2 - S_4)}{(S_3 - S_4 + S_1 + S_2)} * 100\%$ somatosensitive contribution

$Pe = \frac{2*S_4}{(S_3 - S_4 + S_1 + S_2)} * 100\%$ vestibular contribution

In order to minimize the possible effects of artifacts, we take three samples of 10 sec. in each test, calculating the average of the P's in each case.

PATOLOGIE IN ESAME:

- Sclerosi Multipla
- Emiplegia Destra e Sinistra

Test of Balance	T0			T1		
Soggetto	Visivo	Vestibolare	Somato sensitivo	Visivo	Vestibolare	Somato sensitivo
1	23	13	64	0	12	88
2	78	22	0	59	15	26
3	47	26	27	31	16	53
4	0	0	0	15	24	61
5	55	9	36	48	15	37
6	59	0	41	38	18	44
7	0	0	0	54	10	36
8	36	14	50	28	27	45
9	0	0	0	0	0	0
10	46	12	42	45	12	43
11	31	9	60	44	8	48
Media	34.1	9.5	29.1	32.9	14.3	43.7
Mediana	36.0	9.0	36.0	38.0	15.0	44.0
dev st	26.3	9.1	25.2	20.4	7.4	21.7
			Test t T0/T1	0.864	0.168	0.050

Se l'unico strumento che uno possiede è il martello .....

..... tratterà ogni problema come se fosse un chiodo !