CLINICAL NOTES

Unilateral Neglect Syndrome Rehabilitation by Trunk Rotation and Scanning Training

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ABSTRACT. Wiart L, Bon Saint Come A, Debelleix X, Petit H, Joseph PA, Mazaux JM, Barat M. Unilateral neglect syndrome rehabilitation by trunk rotation and scanning training. Arch Phys Med Rehabil 1997;78:424-9.

Objective: Assessment of a new rehabilitation method for unilateral neglect syndrome (UNS), using a specific device (Bon Saint Come's device) that associates exploratory reconditioning with voluntary trunk rotation.

Design: Study 1, randomized control trial during 2 months; study 2, nonrandomized control trial during 2 months.

Setting: Neurorehabilitation units in private and public center.

Patients: In study 1, 22 consecutive patients with UNS resulting from recent stroke (<3 months) were randomly assigned to an Experimental Group (11 patients) or to a Control Group (11 patients). The 2 groups were very similar in terms of general and neurological data. In study 2, 5 consecutive patients with chronic UNS resulting from an old stroke (>6 months) showing the same characteristics were included.

Intervention: In study 1, patients in Group E followed the experimental program 1 hour a day for 1 month (20 hours) and Group C followed usual neurorehabilitation during the same time. In study 2, every patient followed the experimental program 1 hour a day for 1 month (20 hours).

Main Outcome Measures: Assessment in both studies was done at day 0, day 30, and day 60 using a battery of UNS tests (Albert, Scheckenberg, bell) and an activities of daily living (ADL) test (the Functional Independence Measure [FIM]). Mean scores of each test were compared between the 2 groups with the Wilcoxon nonparametric test.

Results: In study 1 all UNS test results and the FIM improved significantly more in Group E than in Group C. In Group E, UNS disappeared in 5 patients and improved in 6. In Group C, UNS disappeared in 1 patient, improved in 4, and was unchanged in 6. In Study 2, UNS remitted in 2 patients, improved in 2 patients, and was unchanged in 1.

Conclusion: The Bon Saint Come method seems to significantly improve recent and chronic UNS, as well as ADL function. These encouraging results could have resulted from a synergistic effect of spatial reconditioning and voluntary trunk rotation. It must be assessed by a new study with more patients.

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UNILATERAL NEGLECT syndrome (UNS) is a frequent[1-3] syndrome altering the functional prognosis[4] of associated, recent (less than 3 months), and chronic (more than 6 months) hemiplegia that poses important therapeutic problems. Rehabilitation of UNS, which began on an empirical basis in the 1960s and 1970s, is the object of a recent development brought on by the findings of new experimental models.[5] Based on such studies, several authors have speculated that the body axis would be the referent of an individual's sensory-motor[5] and mental[6] egocentric space. Under these conditions, UNS would result from the lateral displacement of this referent due to brain lesions. In addition, other studies have shown the possibility of temporarily recentering the egocentric referent with transitory remission of UNS through visual,[7] sensitive,[8] motor,[9] vestibular,[10] auditive,[11] or cognitive[12] activation of the neglected hemifield. Karnath et al[13] in 1993 studied the effect of trunk rotation and vibratory stimulation of the neck in 3 patients with UNS. They showed that a 15° left rotation of the trunk or a vibratory stimulation of the left side of the neck induced decreases in left omissions of 20% to 30%. Conversely, right rotation or stimulation did not modify UNS. They postulated that neurological processes activated by these techniques might participate in the generation of egocentric references used in spatial exploratory activity.

Diller and Riley,[14] Gordon and colleagues,[15] and Weinberg and colleagues[16,17] developed a method of spatial reconditioning that makes use of visual (scanning machine) and proprioceptive (dummy) biofeedback. This method is based on five successive phases: left visual fixation by a visual cue (eg, a spotlight), slow visual exploration of the spatial field toward the right beginning from the cue on the left, identification of the target, execution of the task (eg, touching the target), and biofeedback consisting of a visual or auditive signal informing the patient of his success or failure. This technique can be adapted to any kind of activity. The results from randomized series of patients with recent UNS are encouraging but partially inconclusive. Significant improvement in UNS is obtained in test situations, but little progress is observed in activities of daily living (ADL).

Bergego and coworkers[18] and Robertson and associates,[19] using a computerized method failed to show any statistical improvement. Recently, however, Antonucci and colleagues[20] reported the success of a 2-month course of cognitive rehabilitation on UNS and autonomy following an open trial by Pizzamiglio et al.[21]

We decided to test the hypothesis that the usual reconditioning method might be potentiated by adding a trunk-control task. One of us (ABSC) conceived a biofeedback device that subordinates visual spatial exploration to voluntary rotation of the trunk. The goal was to improve on Diller's results. The method of these investigations was established during a preliminary open study of 6 patients with recent UNS[22] that showed promising results as to the feasibility of the technique. Based on these initial findings, we decided to simultaneously undertake two studies, a controlled study concerning recent UNS (<3 months [Study 1]), and an open study for chronic UNS (>6 months [Study 2]).

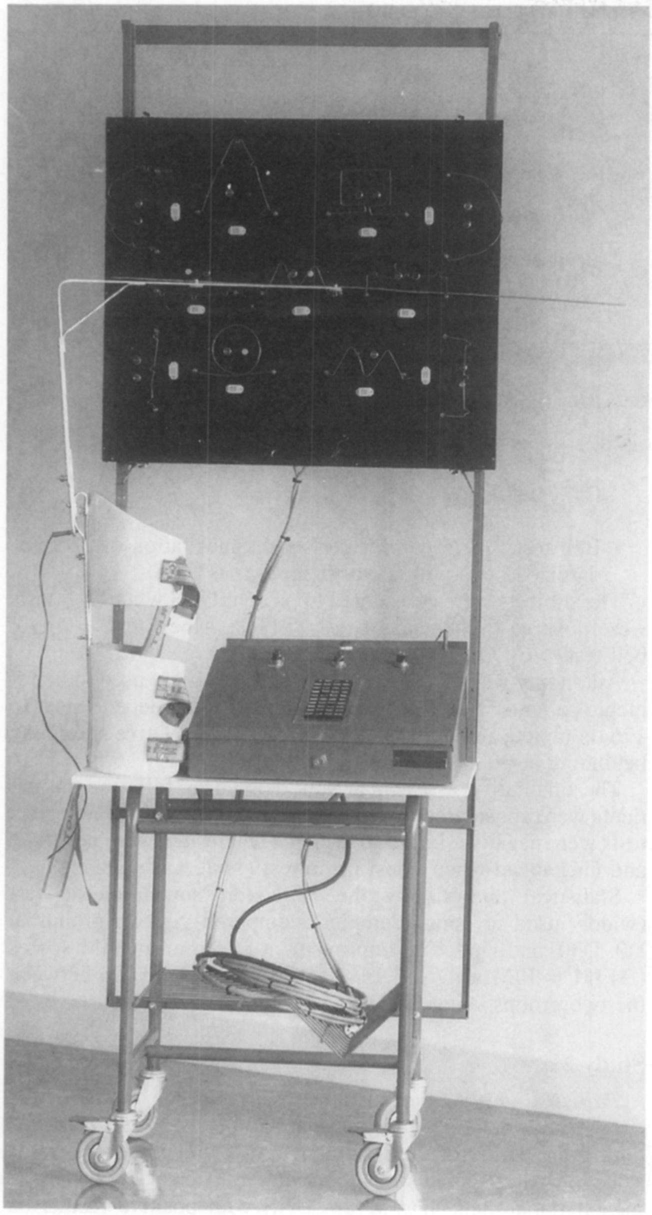

Fig 1. Bon Saint Come's device.

The purpose of these studies was to test the efficacy of the Bon Saint Côme method on UNS and ADL.

METHODS

Device and Principles of Use

The device (fig 1) consists of two parts connected by an electrical circuit and a command keyboard powered by a 12-volt battery. The first part of the system is a polysar thoracolumbar vest to which is attached a vertical metal bar that projects forward horizontally just above the apex of the subject's head. The extremity of the bar, or pointer, is situated 1.5 meters in front of the patient, who is forced to make an axial rotation of the trunk under visual control to displace the pointer laterally and explore the spatial field. For the patient, this activity is totally new and specific, ensuring a stimulation of the attention of the trunk posture activity.

The second part of the device consists of a series of targets attached to a mobile wooden panel placed in front of the patient. The targets, of different geometric form, house an electrical circuit connected to a light bulb and to a buzzer. When the pointer is brought into contact with the target, audible and luminous signals are elicited, producing a biofeedback effect. The therapist can also emit these signals using the keyboard.

Use of the device is simple, directly inspired from the exploratory reconditioning developed by Diller et al.[14-17] The individual progress of the patient is respected. The initial exercises, carried out from a sitting position are usually short: 15min for the first session, increasing to 30min, 40min, then 60min, according to the patient's capacities. The patient must learn how to use the device, visualizing the pointer and moving it by trunk rotation. The patient then must detect the visual and audible signals and touch the corresponding target with the pointer. If the patient succeeds, the same signals are emitted, providing positive feedback. An incorrect maneuver provokes no response and the patient is asked to try again. During the first sessions, we initiated the spatial research from the right to the left visual side. We then applied Diller's method. After gaining adequate control of the trunk (usually acquired in 3 to 5 sessions), the patient is incited to perform the same exercises in a standing position (fig 2) with the help of the physiotherapist. When standing equilibrium is acquired (usually 10 to 15 sessions are necessary for this), the patient can practice the exercises without help

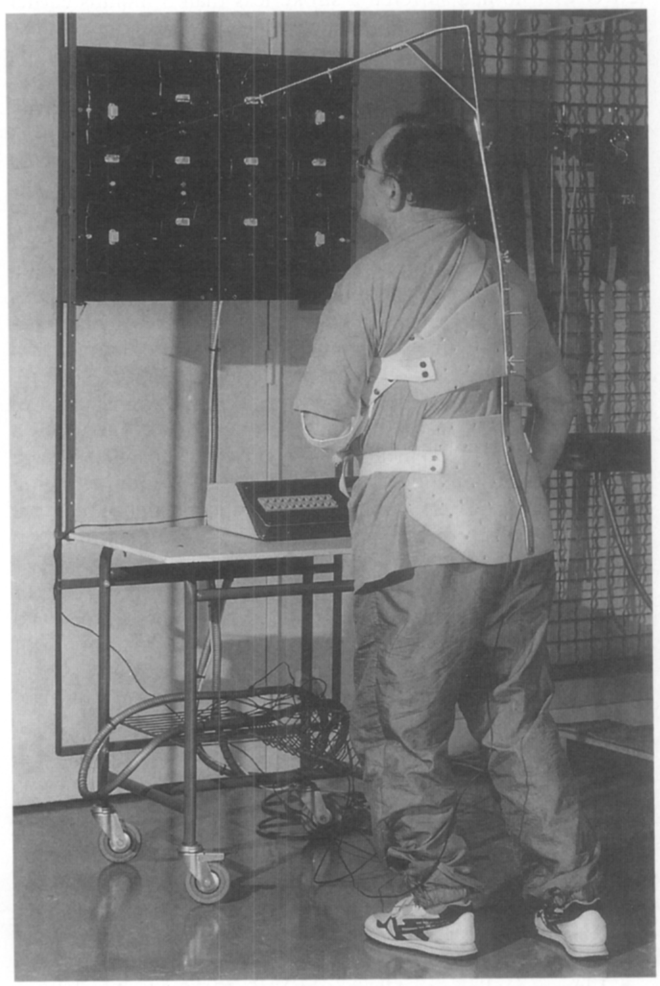

Fig 2. An example of left axial rotation.

Table 1: Study 1 (Recent UNS) Demographic and Clinical Data at DO

	Sex, F/M	Age, years (SD)	Time After Onset, days (SD)	Stroke Size	Motor Impairment	Visual Field Defect	MMSR, /100* (SD)	UNS Schekenberg, %RD† (SD)	UNS Bells, /18‡ (SD)	UNS Albert, /20§ (SD)	FIM, /126‖ (SD)
Experimental group (*n* = 11)	5/6	66 (8)	35 (9)	C: 2 SC: 3 CSC: 6	Hemiplegia, 6 Hemiparesis, 3 None, 2	Hemianopsia, 2 Extinction, 6 None, 3	84 (6)	50 (22)	13 (2)	14 (6)	66 (18)
Control group (*n* = 11)	5/6	72 (6)	30 (4)	C: 3 SC: 2 CSC: 6	Hemiplegia, 8 Hemiparesis, 2 None, 1	Hemianopsia, 2 Extinction, 5 None, 4	81 (4)	53 (27)	14 (3)	16 (4)	54 (10)
p	NS	<.02¶	NS	NS	NS	NS	NS	NS	NS	NS	<.01¶

Abbreviations: C, cortex; SC, subcortex; CSC, cortex and subcortex; MMSR, Mini Mental Status Revised; NS, not significant.
* MMSR cutoff score: 74/100.
† Line bisection test; %RD refers to mean percentage of right bisection deviation on 20 standardized lines (cutoff score: >11%).
‡ Cancellation of 36 standardized bells (cutoff score: more than 6 left omissions).
§ Line cancellation of 40 standardized lines (cutoff score: more than 2 left omissions).
‖ FIM cutoff score: 90/126.
¶ Significant.

or with a crutch. The therapist participates actively throughout the sessions, stimulating the patient, guiding the patient to the left side and correcting the patient's posture. A more complete explanation of the exercises will be published in the near future.

Study 1

Subjects. Over a period of 2 years, 22 patients with severe left UNS who had suffered a stroke less than 3 months earlier were included in the study (all gave oral consent). Trunk control was not a selection criterion; patients with good and poor trunk control were included in both groups. The patients were hospitalized in two neurorchabilitation units. They were randomly divided into two groups (using a randomization table)—group E, experimental ($n = 11$), and group C, control ($n = 11$)—and prospectively monitored for 2 months. UNS was defined by the positivity of a battery of three tests that have been described.[23-25] Patients presenting a history of stroke, alteration of general status, or cognitive difficulties incompatible with rehabilitation were excluded. The two groups, whose general characteristics are shown in table 1, were comparable for the following parameters: sex ratio (5 women and 6 men in each group), brain lesion (time since occurrence, 30 to 35 days after onset; localization), global cognitive status defined by the Mini Mental Status Revised (MMSR),[26] sensory-motor deficit, and UNS. There was a slight difference in the mean age of the two groups, the average age of group E being 66 ± 8 years and that of group C being 72 ± 6 years ($p < .02$). Initial functional independence measure (FIM) was slightly higher in group E (66 ± 18) than in group C (54 ± 10) ($p < .01$).

Protocol. Every day for 20 days, group E received 1 hour of the experimental treatment with one of us (ABSC), followed by 2 to 3 hours of traditional rehabilitation (1 to 2 hours of physiotherapy, 1 hour of occupational therapy). Group C benefited from 3 to 4 hours of traditional rehabilitation each day. Thus, the time of rehabilitation was the same in both groups. The assessment was done at day 0 (D0), D30 (end of treatment), and D60 (1 month after the end of treatment) by one of us (LW).

The quantitative assessment of UNS was carried out using a battery of conventional paper and pencil tests:

- Line bisection, Schekenberg test[24] evaluating the average percentage deviation to the right of the bisector of 20 standardized horizontal lines. The cutoff score was 11% of right deviation (%RD).
- Line cancellation, Albert test[25] of 40 standardized lines with a cutoff score at 2 left omissions (LO).
- Bell test,[24] bell identification and cancellation of 36 standardized bells with a cutoff score at 6 LO.

The subjects were considered to present UNS when all 3 tests were positive (Schekenberg test, >11%; Albert test, >2 LO; bell test, >6 LO).

Autonomy was evaluated with the FIM, widely used in hemiplegic patients. This scale ranges from 18 (total dependence) to 126 (complete autonomy) with a threshold of relative autonomy beginning at 90.

The qualitative assessment was defined as follows: the patients were considered as remitted when results of the 3 neglect tests were negative, improved when 2 test results were negative, and unchanged when 1 test or no test result was negative.

Statistical analysis by the Wilcoxon nonparametric test (widely used for small samples) compared the two groups at D0, D30, and D60. The improvement of the mean FIM scores (ΔFIM = FIM at DX − FIM at DY) was compared between the two groups using the Wilcoxon test.

Study 2

Patients. Five other patients with chronic, stable UNS (from 6 to 7 months) were selected and prospectively followed during the period of the first study. All of them met the same selection criteria as in study I—a first unique stroke, no severe mental impairment, and severe UNS with positive results on the 3 neglect tests described above. Details of general and clinical data are shown in table 2.

Method. Every subject followed the experimental program described above associated with traditional physiotherapy for 1 month with a clinical and functional evaluation at D0, D30, and D60. In this case study, no statistical analysis was performed. Qualitative results were calculated as previously described: UNS remission when 3 neglect tests results were negative, improvement when 2 neglect test results were negative, and unchanged when 1 or 0 neglect test result was negative.

RESULTS

In study I, all the subjects of group E as well as those of group C were able to follow the entire rehabilitation program without noteworthy side effects (just a certain tiredness after the first training sessions). The majority of group E showed an improvement in equilibrium and vision from the first training sessions.

Quantitative results of neglect tests at D30 showed:

- First, an improvement in all test results in both groups,

Table 2: Study 2 (Chronic UNS) Demographic and Clinical Data at DO

Patients	Sex	Age, years	Time After Onset, months	Stroke Size	Motor Impairment	Visual Field Defect	MMSR,/100*
1	M	65	6	C	Hemiparesis	None	88
2	M	65	7	C	Hemiplegia	None	75
3	F	74	6	CSC	Hemiparesis	Extinction	89
4	M	67	6	CSC	Hemiparesis	Hemianopsia	87
5	M	69	6	C	Hemiparesis	Extinction	90

Abbreviations: C, cortex; CSC, cortex and subcortex.
* Mini Mental Status Revised cutoff score: <74/100.

but especially in group E: In group C, the Schekenberg test score went from 53% (SD, 22) of right deviation (RD) at D0 to 45% (SD, 25) at D30, the bell test score from 14 ± 3 LO to 13 ± 4 LO, and the Albert test score from 16 ± 4 LO to 12 ± 7 LO. In group E, the Schekenberg test score went from 50% (SD, 27) of RD at D0 to 17% (SD, 14) at D30, the bell test score from 14 ± 2 LO to 6 ± 4 LO, and the Albert test score from 14 ± 5 LO to 4 ± 4 LO.

- Second, a significant improvement in all test results at D30 in group E compared to the results in group C: Schekenberg test (fig 3) 45% (SD, 25) in group C versus 17% (SD, 14) of RD in group E ($p < .01$); bell test 13 ± 4 LO in group C versus 6 ± 4 LO in group E ($p < .02$); Albert test 12 ± 7 LO in group C versus 4 ± 4 LO in group E ($p < .05$). The quantitative results of neglect tests at D60 (fig 3) were slightly improved in both groups maintaining the same differences between groups C and E.

The quantitative results of autonomy (FIM score) at D30 are presented in figure 4, showing:

- First, an improvement in FIM score at D30 in both groups, especially in group E. In group C, FIM scores went from 54 ± 10 at D0 to 62 ± 14 at D30, an 8-point improvement (ΔFIM = 8). In group E, FIM scores went from 66 ± 17 at D0 to 86 ± 23 at D30 (ΔFIM = 20). The improvement was significantly higher in group E ($p < .03$).
- Second, a stabilization of the improvement after D30 with a gain of 7 points in both groups (NS).

The qualitative results are presented in table 3, showing at D30: in the control group, 1 remission, 4 improvements, and 6 stagnations; in the experimental group, 5 remissions, 6 improvements, and no stagnation. These results were maintained at D60.

In study 2, as in study I, no complication occurred, and participation in the exercises was excellent.

Quantitative results of UNS testing and FIM scores were good in all cases, except in case 3, in which there was a significant reduction in UNS (table 4).

UNS remitted in 2 cases (cases 2 and 4), improved in 2 (cases 1 and 5), and remained unchanged in 1 (case 3). Amelioration in autonomy (FIM) followed UNS improvement with a gain of 19 points in case 2, 25 points in case 1, 17 points in case 5, and only 4 points in case 3. All of these results were maintained at D60, 1 month after the end of treatment without any further improvement.

DISCUSSION

Our patients in both studies were representative of the most serious cases of hemiplegic and hemineglígent patients. We voluntarily chose such a population to test our method in the most difficult situation.

During both studies, no serious side effect was observed. However, patients did report tiredness during the initial sessions, reflecting the intensity of the work they performed. The method was reliable and, in most cases, attractive to the patient and the therapist. For example, every patient easily accepted the device. This point is particularly noteworthy in view of the relative lack of motivation for rehabilitation generally manifested by this type of patient. The initially poor trunk control posed no problem, and was rapidly improved by the first 2 to 4 sessions.

The quantitative results of study I showed a clear and significant improvement (usually more than 50%) of UNS in the treated group at D30 in comparison to the initial status and to the control group results. Autonomy measured on a standard scale was also improved in the treated group (for equal motor deficits), suggesting that this experimental management was responsible for recovery of exploratory behavior in daily life and for the concomitant remission of UNS. FIM subtests included no UNS criterion and FIM cannot be artificially ameliorated by an improvement of UNS. Such was not the case of the functional evaluation of hemi-inattention in extrapersonal space used recently by Antonucci.[20] The latter test is more sensitive than FIM to specific improvements of UNS. Our results were maintained 1 month after the end of treatment, favoring the hypothesis of a veritable relearning phenomenon of spatial scanning. Moreover, no new significant improvement could be noted in group E after the end of the treatment. This clearly suggests that patients in group E attained their maximum functional capacities within the period of the experimental treatment.

Qualitative improvement was observed in all patients of the treated group, but UNS disappeared in only 5 of 11 cases, which suggests that for the 6 other patients, capacity for recovery was saturated or the duration of treatment was too short. Conversely, in the control group, only one patient recovered, 4 improved, and 6 stagnated, indicating a probable underexploitation of their recovery potential. In other words, this experimental program seems to optimize the improvement of the patients but could be limited by the individual's potential for improvement.

These good results must be moderated by some methodological criticism. First, the average age of the treated group was less than that of the controls (66 years compared to 72 years), probably because randomization is less reliable in small groups of patients. Young age is usually a good prognostic factor for improvement in stroke, and it probably favored recovery in the experimental group to some extent. However, we do not think that this age difference alone can explain the amelioration observed in group E.

Second, the potential placebo effect of the rehabilitation apparatus itself must be taken into account. To our knowledge, no study to date has addressed this phenomenon in UNS rehabilitation. Robertson[28] recently supported such speculation by showing that rehabilitation of vigilance alone improves UNS. It would not be surprising to learn that the technological aspect of the device could be a reassuring element for patients, favoring vigilance and motivation. Indeed, this appeared to be the case

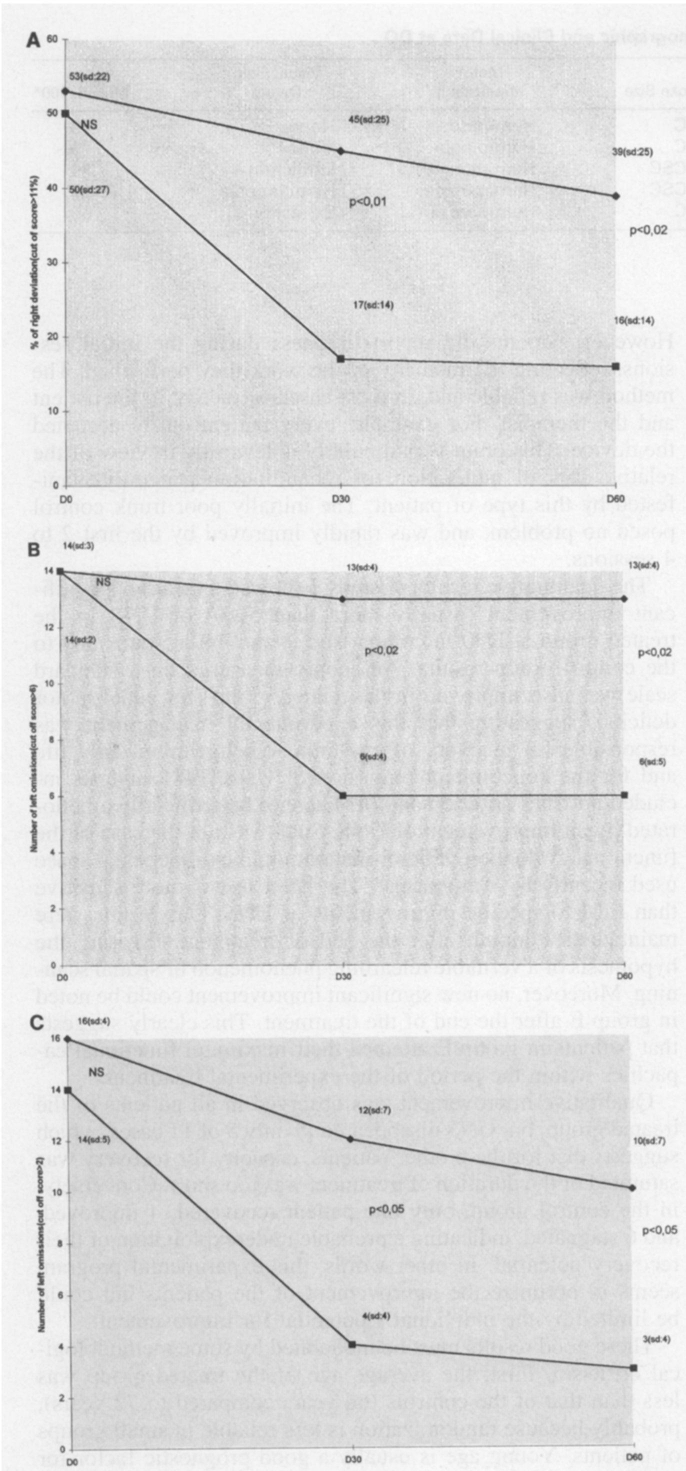

Fig 3. (A) Quantitative outcome of UNS on Schekenberg test (♦, control group; ■, experimental group). (B) Quantitative outcome of UNS on bell test (♦, control group; ■, experimental group). (C) Quantitative outcome of UNS on Albert's test (♦, control group; ■, experimental group).

in some subjects, but several others were slightly frightened by the apparatus or indifferent, which would seem to exclude a placebo effect for them. These patients received more information and reassurance, permitting them to continue with the experimental program like the others. Attempts will be made later on to determine the importance of such an effect.

Third, the lack of a specific trunk control test is regrettable.

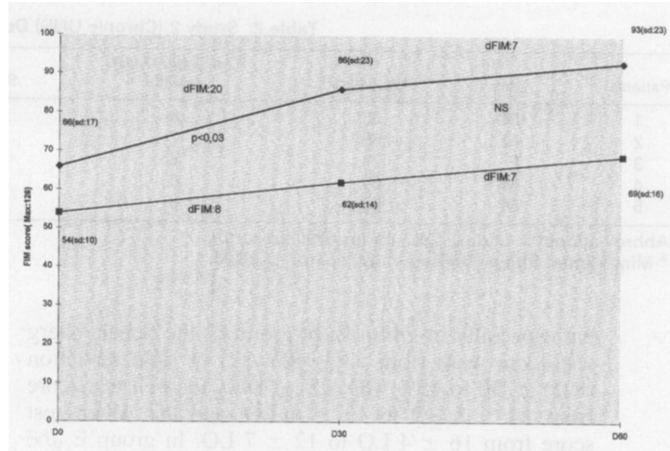

Fig 4. FIM outcome (♦, experimental group; ■, control group).

It would probably have shown a substantial improvement in the control of the trunk in group E. This point could be tested in future studies.

Our results, compared to those of studies using a similar protocol (recent UNS, experimental versus control groups) with classic visual-cognitive rehabilitation, seem more convincing. In influential work published by Diller, Weinberg, and Gordon, as well as that reported more recently by Antonucci, a program of 30 to 40 hours (over a 2-month period) was necessary to achieve a significant result in UNS and, less constantly, in autonomy. In our study, significant overall results were obtained in both UNS and autonomy after only 20 hours of therapy (1 month). We hope to achieve better results by prolonging the therapy as suggested by Antonucci.[20]

Study 2 involving chronic UNS confirmed all the results of study I and of our previous open study.[22] Improvement took place in exactly the same proportions with a clear advantage in UNS and autonomy. This amelioration occurred during the experimental stage and was followed by stagnation of results after treatment ended. It was important to test our method on chronic patients since a spontaneous improvement may not be expected in them. Our method in chronic UNS also seems to be more effective than the visual-cognitive technique when compared with the results of an open study in the same category of patients carried out by Pizzamaglio.[21] The results we obtained were similar to his, but the rehabilitation period was reduced by half. Again, this speaks for a synergistic effect between trunk rotation and scanning training. As in study I, the method appears to have a direct effect on UNS and to involve an actual relearning of spatial scanning.

One explanation could be a synergistic effect between axial rotation of the trunk, generating specific motor, vestibular, and cerebellar activation, and classic exploratory reconditioning that preferentially activates the cognitive and visual systems. Karnath[30] recently suggested that our spatial referent is constantly building by multimodal stimulations (visual, motor, sensitive,

Table 3: Study I (Recent UNS) Qualitative Outcome of Unilateral Neglect at D30 (Unchanged at D60)

	Experimental Group (*n*: 11)	Control Group (*n*: 11)
Remission*	5	1
Improvement†	6	4
Unchanged‡	0	6

* 3 neglect scales under or equal to the cufoff score.
† 2 neglect scales under or equal to the cutoff score.
‡ 1 or no neglect scale under or equal to the cutoff score.

Table 4: Study 2 (Chronic UNS) Quantitative and Qualitative Results

Patients	Scheckenberg (% RD)*			Bells (/18)†			Albert (/20)‡			FIM (/126)§			Qualitative Result‖
	D0	D30	D60	D0	D30	D60	D0	D30	D60	D0	D30	D60	
1	12	9,5	9,5	10	8	8	3	1	1	77	102	102	Improvement
2	24	2	2	15	2	2	9	1	1	63	82	85	Remission
3	36	12	18	11	10	14	14	12	13	78	82	82	Unchanged
4	38	1	1	14	5	1	12	2	1	79	104	104	Remission
5	68	7	9	11	4	3	8	0	0	86	103	106	Improvement

* Line bisection test, %RD refers to mean percentage of right bisection deviation on 20 standardized lines (cutoff score: 11%).
† Cancellation of 36 standardized bells (cutoff score: more than 6 left omissions).
‡ Line cancellation of 40 standardized lines (cutoff score: more than 2 left omissions).
§ FIM cutoff score: 90/126.
‖ Remission = 3 neglect scales under or equal to the cutoff score: improvement = 2 neglect scales under or equal to the cutoff score; unchanged = 1 or no neglect scale under or equal to the cutoff score.

vestibular, auditive, and/or cognitive). The Bon Saint Côme device induces a multimodal stimulation of attentional and exploratory processes following these recent concepts. A better understanding of these mechanisms should rapidly lead to other new rehabilitation procedures in UNS.

In conclusion, the Bon Saint Côme device is simple, reliable, and safe. We are currently studying how to make the device more effective (using a semicircular panel) and more attractive (using a different design). Axial rotation of the trunk coupled with exploratory conditioning seems to significantly reduce UNS and dependence in subjects presenting recent and chronic UNS. These encouraging results call for confirmation by a multicentric study involving a greater numbers of patients.

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