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360° AI-spine screening and AI-generated 3-minute training compared to classical physiotherapy workout

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Abstract

Physical training is an efficient and cost-effective method of therapy. (31) From an economic point of view, training therapy (in addition to reducing pain and functional limitations) can also lead to a reduction in the number of sick days due to back pain (32).

The purpose of this study was to show how an asymmetrical 3-minutes workout that is calculated by the iPlena-AI can enhance the posture competence and symmetry of the spine, the foot pressure, the lordosis and kyphosis angle. It was an experimental research study that looked at how a customized asymmetrical 3-minutes training program that targets the central nervous system affects the posture competence and symmetry of the spine. The lordosis and kyphosis angle has been measured to identify the influence on the entire posture, also in the sagittal level. The independent variable in study has been the workout with two different conditions; recommended by the iPlena-AI and 5 classical physiotherapeutic exercises - recommended by leading sportmedics. The dependent variable of the study was the difference between pre- and post- BackScan scores on posture competence of the spine. The mediator variable was the symmetry of the posture after each workout that has been evaluated by the iPlena-AI.

The major conclusion to this study was that the iPlena-AI suggested training showed higher effect on the posture competence of the spine score than the standard physiotherapeutic training, also the asymmetry of the subjects improved more after the asymmetrical iPlena-AI suggested workout.

However in this study the subjects didn’t know about the approach of the performed study. Before the photos were taken of the subjects they should make 3 steps on the floor to equalize their stand. This was the only constant after both training sessions. Since the training should run without interrupting, the subjects get briefed carefully before each training session. After the brief of the exercises the training has been solved just by showing the subjects videos of the exercises and how much they have to repeat it on each side.

Key Words: MSK STABILITY, POSTURE DEVIATIONS, POSTURE SCREENING, POSTURE CORRECTION, PROPRIOCEPTION

Current research

The use of stabilisation training is often based on the assumption that non-specific back pain or ISG complaints are the result of structural (i.e. degenerative), biomechanical and motoric deficits leading to segmental or regional instability of the lumbar-pelvic region (1-4). However, there is little evidence that "instability" is the pathoanatomical background of such complaints. There are no studies that demonstrate a clear causal relationship between spinal or pelvic mobility, pain and functional limitations (5,6,12,13).

No study has yet been able to confirm that stabilisation training would actually improve spinal stability. Shamshi et al. (7) showed that neither segmental stabilisation training according to Richardson et al. (3) nor general trunk strength training improves spinal stability (hybrid EMG-based biomechanical model) in back pain patients. The initiation of stabilisation training is often accompanied by unfavorable explanatory models such as. “spinal-instability", "spinal weakness", etc., which we know can negatively influence patients' behavior and emotional health (5,9-13).

Training and physical activity should therefore be adapted to the individual problem, motor pattern and underlying psychosocial factors (13,14,16,17). When patients themselves discover ("learn by discovery") that, for example, changing a movement reduces pain (e.g., by activating the muscle chains into functional patterns), this promotes autonomy, self-efficacy, motivation and willingness to change behavior (13,14,15). Training and exercise as a behavioral experiment can be tremendous "boosters" in this regard (8). Off-the-shelf training cannot do this. Conclusion: "One size does not fit all" - general stabilisation training for every back pain patient is not the optimal solution for a complex problem (8,18).

Methods

Study design

The training was where the independent variable changed. Subjects were divided in 2 groups for the study and were first given a brief about the exercises, also they were supervised how the measure procedure will look like. One group performed the AI-recommended training program, the other group performed the classical physiotherapy exercises. Once they are briefed, they have to start with their exercises. Once they’re ready with the supervised course of exercises, the measurement has been performed without delay. The experimenters then determined a difference from both training post- tests scores.

The 50 subjects have been chosen randomly. The criteria was:

- Chronic problems: MSK pain or tension for longer than 3 months
- Age between 25 - 50
- Sedentary lifestyle: sitting 9,5 hours or more per day

Table 1. Anthropometric and physical characteristics of participants

Subject	Gender	Height,m	Age, years	Weight, kg	in Pain	Sitting per day, h
1	W	1,67	25	62,6	Y	11
2	W	1,72	27	80,4	Y	10
3	W	1,59	49	67,8	Y	9,5
4	M	1,72	26	75,9	Y	10,5
5	W	1,78	29	82,0	N	10
6	M	1,82	27	91,4	Y	12
7	M	1,84	33	86,5	Y	12,5
8	M	1,78	25	81,7	Y	9,5
9	M	1,77	35	82,8	Y	10
10	W	1,69	37	71,1	N	10
11	W	1,59	38	74,0	N	12,5
12	W	1,61	45	65,7	N	13
13	W	1,63	44	70,4	Y	11
14	W	1,60	50	62,5	Y	10
15	M	1,80	29	93,3	Y	10
16	W	1,67	32	74,8	Y	11
17	W	1,64	37	62,9	Y	10
18	W	1,68	38	61,5	Y	9,5
19	M	1,92	39	112,4	N	9,5
20	W	1,62	28	65,2	N	11,5
21	M	1,90	33	107,2	Y	11
22	M	1,87	38	91,0	N	10
23	W	1,65	42	72,3	N	10,5
24	M	1,80	44	91,3	N	10

25	W	1,69	48	78,2	Y	14
26	M	1,68	39	74,1	Y	12
27	W	1,66	41	72,0	Y	12,5
28	W	1,65	30	77,9	Y	14
29	M	1,71	45	73,4	Y	12,5
30	M	1,77	50	71,5	Y	10
31	M	1,75	48	82,4	N	10,5
32	W	1,72	26	77,3	Y	10
33	W	1,66	37	72,0	Y	9,5
34	M	1,74	32	78,2	Y	12
35	W	1,68	32	71,7	Y	11
36	M	1,79	30	84,3	Y	10,5
37	W	1,63	28	72,2	Y	10
38	W	1,65	32	71,0	Y	9,5
39	W	1,73	44	82,8	Y	11
40	W	1,76	40	77,2	Y	11
41	W	1,68	43	73,1	Y	12
42	M	1,78	42	97,0	Y	9,5
43	M	1,84	44	102,2	Y	10,5
44	M	1,88	32	93,1	Y	12
45	M	1,84	38	92,0	N	11
46	M	1,85	39	88,1	N	10,5
47	M	1,79	41	82,0	N	11
48	W	1,68	29	71,1	Y	9,5
49	W	1,64	33	59,2	Y	10
50	W	1,71	39	62,4	N	10

Measurements

DIERS 4D-Motion Lab

1) Pelvic obliquity

   For pelvic assessment participants performed a static measurement of the spine using 4D-Motion Lab (DIERS, Germany). Participants should achieve a straight pelvic position (0mmR/0mmL).

2) Kyphosis angle

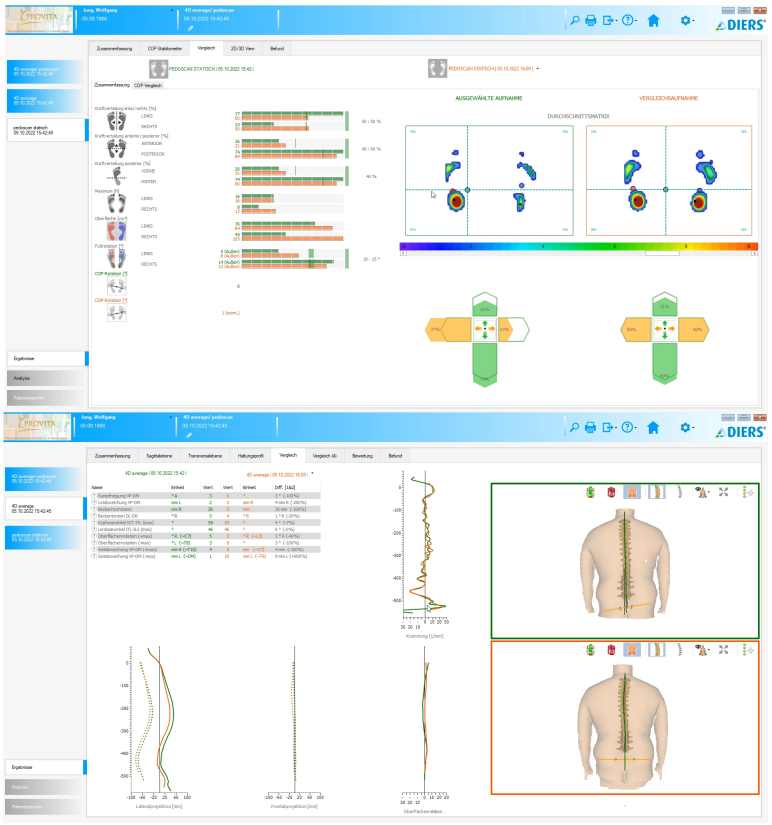
   For the assessment of the kyphosis angle participants performed a static measurement of the spine using 4D-Motion Lab (DIERS, Germany). Participants should achieve an optimal kyphosis angle of 30-40 degrees.

3) Lordosis angle

   For the assessment of the lordosis angle participants performed a static measurement of the spine using 4D-Motion Lab (DIERS, Germany). Participants should achieve an optimal kyphosis angle of 40-50 degrees.

4) Foot pressure

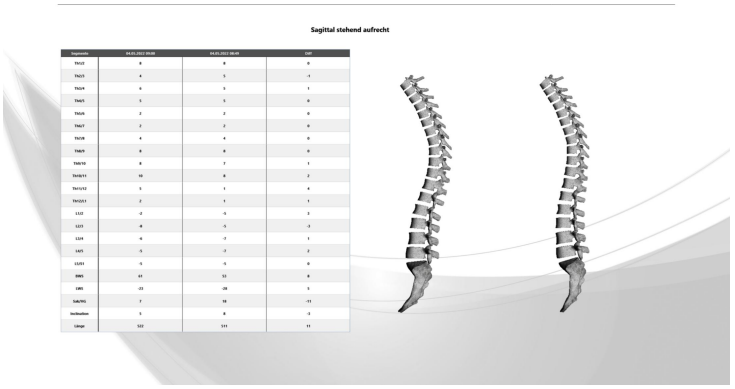
   For the assessment of the foot pressure participants performed a static foot pressure analysis using 4D-Motion Lab (DIERS, Germany). Participants should achieve an optimal foot pressure relation of 50% | 50%.

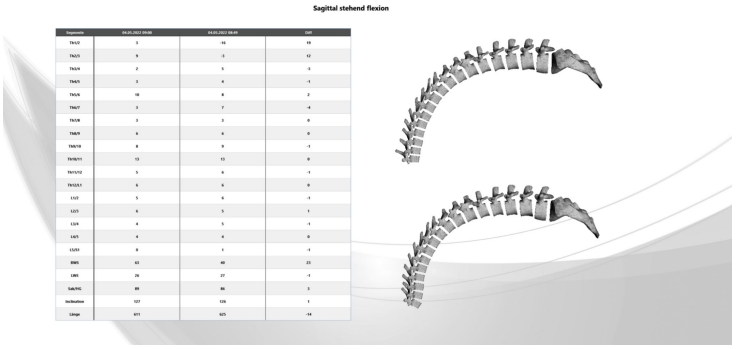


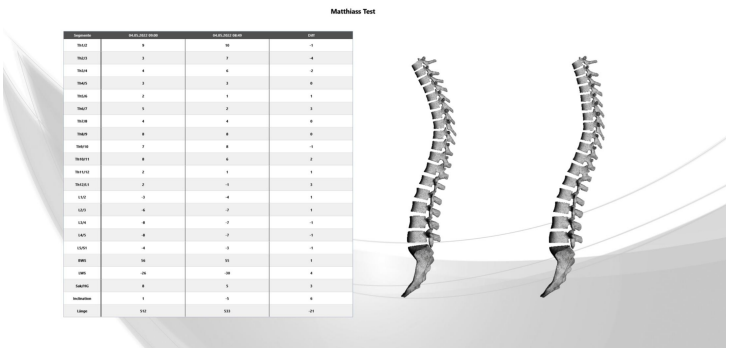
BackScan

1) Posture evaluation

For the evaluation of the posture participants performed a Back mobility and strength analysis using BackScan (MobeeMed, Germany). Participants should achieve an optimal posture evaluation that depends on the statistical data that has been collected from people in their age. The highest possible evaluation is 100%.







2) Posture holding competence

For the evaluation of the posture holding competence participants performed a Back mobility and strength analysis using BackScan (MobeeMed, Germany). Participants should achieve an optimal posture holding competence that depends on the statistical data that has been collected from people in their age. The highest possible evaluation is 100%.

iPlena-AI suggested training program

The asymmetric training program is always individually adapted to the posture deviations from the user. It is based on PNF, Akrodynamik and Neuroathletic. The main aim of the individual training program is to reprogram the central nervous system to improve the symmetry and the spinal posture. By making the patient understand what actually the holistic problem is and how to solve it, there is much more compliance from the patient. In this case the autonomy, self-engagement, motivation and the will to change something is enhanced (13,14,15). It prevents the Arthrogene Muskelinhibition that causes a reduction of motoneurons that can be activated at will. This leads to a lower "neurophysiological variability" and an early fatigue of the still activated units. The system develops compensatory strategies as a result. AMI causes a loss of strength and atrophy of the affected muscles, often persists over a longer period of time and thus represents a limiting factor in rehabilitation. (19-30).

Control group

5-minutes exercise program from Prof. Dr. Gerhard Huber

His references:

- Sports scientist at the University of Heidelberg
- Board member of the German Association for Health Sports and Sports Therapy
- Lecturer at the University of Salzburg
- Quality auditor in the health sector (TÜV®)

Main research interests:

- Evaluation research on physical activity programmes in prevention and rehabilitation, quality management, workplace health promotion, "aging workforce"
- Member of the Board of DVGS
- Member of the Spokesperson's Council of the Health Commission of the German Association for Sport Science
- Member of the extended board of the Platform for Nutrition and Physical Activity
- Member of the scientific advisory board of the German Network for Health Promoting Hospitals (DNfK)
- Member of the AG Bewegung in the German Association for Rehabilitation Science (DGRW)
- Member of various working groups of the Member of various working groups of the German Pension Insurance Association

(https://www.issw.uni-heidelberg.de/personal/homepage/huber_g.html)

Prof. Dr. Gerhard Huber exercises:

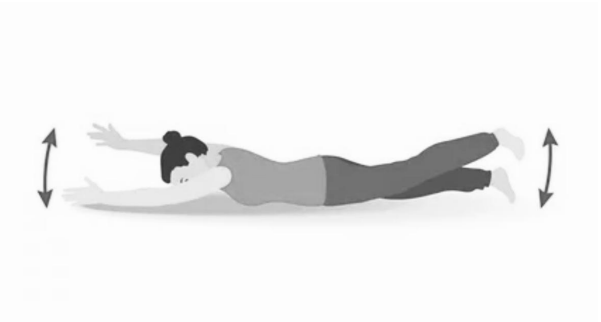
8 times each side - shoulder rotation forward/backwards

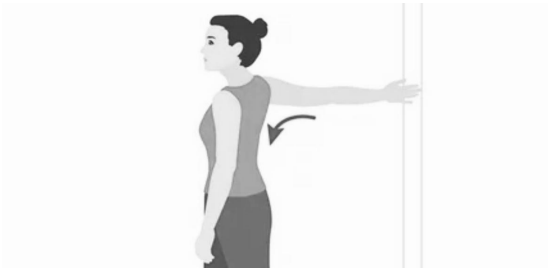
20 seconds - diagonal laying swimmer

8 times - shoulder up/down

5 seconds each side - stretching hamstrings

5 seconds each side - stretching chest muscle





Results

The research outcome has been that the iPlena-AI suggested exercises of 3-minutes has shown a significant change in symmetry of their posture. The symmetry has been measured by the deviation-detection of the AI. Measured key indicators:

- Foot pressure
- Lordosis angle
- Kyphosis angle
- Posture holding competence
- Posture evaluation

The symmetry has been evaluated by the absence of deviation at the key indicators. Research outcomes show that after the first workout of the control group the bad asymmetric posture gets more prominent in 64% of the cases. The AI-suggested asymmetrical workout shows a significant improvement on the symmetry in 93% of the cases. In 24% of the cases one indicator gets more asymmetric while the rest of the symmetry indicators show significant improvements (>50%).

The AI-suggested asymmetrical workout shows a significant improvement (>20%) on the even foot load in 96% of the cases, compared to the control group where the even foot load has significantly improved in 12% of the cases.

57% of the test group stated that they felt a noticeable reduction in pain after the first training session, while 12% of the control group stated this. 4% of the test group reported a slight intensification of pain, while in the control group it was 32%.

Improvement of the Posture holding competence and posture assessment measured in 96% of the participants measured in the test group, while this was the case in 32% of the control group.

Table 2. Changes after training. Correlation between AI-Training (1.-25.) and classical physiotherapeutic workout (26.-50.)

	DIERS 4D-Motion Lab				BackScan	
	Pelvic obliquity (r/p)	Kyphosis Angle (r/p)	Lordosis angle (r/p)	Foot load left|right (r/p)	Posture evaluation (r/p)	Posture holding competence (r/p)
1	2mmL / 1mmL	59° / 48°	64° / 45°	46%|54% / 49%|51%	62% / 72%	22% / 58%
2	3mmR / 0mmR	57° / 52°	68° / 47°	42%|58% / 45%|55%	35% / 42%	39% / 62%
3	2mmR / 1mmL	39° / 37°	49° / 41°	39%|61% / 47%|53%	44% / 51%	35% / 55%
4	5mmL / 2mmL	58° / 49°	63° / 48°	44%|56% / 50%|50%	38% / 43%	44% / 63%
5	7mmR / 2mmR	51° / 41°	61° / 52°	57%|43% / 49%|51%	22% / 37%	51% / 61%
6	4mmL / 1mmL	56° / 52°	34° / 41°	64%|36% / 53%|47%	33% / 42%	22% / 47%
7	2mmR / 1mmL	59° / 57°	59° / 47°	46%|54% / 50%|50%	36% / 46%	28% / 52%
8	4mmR / 2mmR	48° / 42°	54° / 46°	74%|26% / 63%|37%	45% / 48%	32% / 59%
9	5mmL / 1mmL	40° / 38°	69° / 51°	42%|58% / 49%|51%	32% / 36%	42% / 67%
10	8mmL / 2mmL	62° / 58°	53° / 48°	40%|60% / 52%|48%	41% / 44%	32% / 51%
11	3mmR / 0mmR	57° / 52°	62° / 53°	47%|53% / 48%|52%	34% / 37%	29% / 62%
12	1mmL / 1mmL	63° / 58°	66° / 47°	57%|43% / 50%|50%	35% / 39%	34% / 43%
13	3mmL / 1mmL	45° / 42°	59° / 48°	36%|64% / 44%|56%	21% / 30%	44% / 65%
14	6mmR / 4mmR	41° / 38°	64° / 51°	46%|54% / 48%|52%	42% / 38%	49% / 72%
15	5mmL / 1mmL	69° / 57°	57° / 43°	52%|48% / 49%|51%	43% / 44%	29% / 46%
16	3mmR / 2mmR	48° / 44°	64° / 55°	41%|59% / 48%|52%	34% / 37%	34% / 37%

17	5mmL / 0mmL	68° / 62°	60° / 51°	44%|56% / 50%|50%	42% / 47%	52% / 64%
18	3mmL / 1mmL	61° / 57°	44° / 48°	37%|63% / 44%|56%	31% / 28%	22% / 24%
19	4mmL / 0mmL	52° / 48°	39° / 45°	45%|55% / 51%|49%	28% / 44%	34% / 52%
20	2mmL / 1mmL	65° / 56°	55° / 49°	48%|52% / 49%|51%	35% / 42%	23% / 44%
21	6mmR / 5mmR	49° / 47°	63° / 54°	41%|59% / 46%|54%	34% / 37%	61% / 75%
22	5mmL / 6mmL	52° / 48°	65° / 57°	66%|34% / 58%|42%	28% / 47%	45% / 53%
23	4mmR / 2mmR	44° / 42°	59° / 61°	43%|57% / 42%|58%	33% / 39%	54% / 62%
24	2mmL / 0mmL	68° / 59°	62° / 58°	37%|63% / 43%|57%	45% / 47%	35% / 74%
25	4mmL / 1mmR	59° / 47°	69° / 59°	47%|53% / 49%|51%	38% / 43%	62% / 72%
26	5mmL / 5mmL	68° / 66°	64° / 67°	57%|43% / 59%|41%	43% / 41%	34% / 38%
27	3mmR / 4mmR	58° / 61°	59° / 57°	46%|54% / 42%|58%	37% / 38%	39% / 42%
28	2mmL / 4mmL	49° / 52°	61° / 63°	47%|53% / 47%|53%	28% / 28%	28% / 27%
29	6mmL / 5mmL	66° / 65°	49° / 48°	38%|62% / 40%|60%	33% / 35%	39% / 39%
30	3mmL / 4mmL	68° / 68°	66° / 64°	66%|34% / 72%|28%	37% / 38%	43% / 47%
31	5mmR / 6mmR	57° / 52°	65° / 64°	49%|51% / 46%|54%	27% / 26%	52% / 48%
32	3mmR / 4mmR	62° / 64°	63° / 59°	39%|61% / 35%|65%	35% / 32%	38% / 41%
33	2mmL / 5mmL	67° / 65°	69° / 67°	62%|38% / 60%|40%	42% / 44%	42% / 51%
34	6mmR / 4mmR	56° / 57°	51° / 48°	46%|54% / 41%|59%	48% / 44%	55% / 49%
35	4mmL / 6mmL	61° / 60°	62° / 59°	43%|57% / 39%|61%	37% / 39%	54% / 51%
36	5mmR / 7mmR	52° / 54°	60° / 57°	49%|51% /	44% / 47%	61% / 63%

				42%|58%		
37	2mmL / 0mmL	55° / 52°	72° / 69°	36%|64% / 35%|65%	48% / 45%	31% / 30%
38	4mmL / 3mmL	38° / 42°	54° / 54°	46%|54% / 44%|56%	29% / 34%	24% / 27%
39	2mmR / 5mmR	49° / 53°	63° / 58°	43%|57% / 42%|58%	37% / 35%	39% / 42%
40	4mmR / 6mmR	63° / 61°	70° / 68°	44%|56% / 49%|51%	26% / 32%	52% / 62%
41	5mmL / 7mmL	47° / 45°	61° / 58°	57%|43% / 62%|38%	23% / 27%	34% / 36%
42	1mmL / 1mmR	64° / 66°	59° / 62°	46%|54% / 44%|56%	44% / 40%	39% / 45%
43	1mmL / 2mmL	57° / 59°	64° / 59°	28%|72% / 24%|76%	39% / 33%	29% / 32%
44	3mmL / 3mmL	48° / 48°	45° / 48°	49%|51% / 52%|48%	26% / 26%	51% / 55%
45	2mmL / 4mmL	66° / 64°	37° / 39°	74%|26% / 78%|22%	37% / 39%	62% / 63%
46	7mmR / 5mmR	69° / 68°	43° / 52°	46%|54% / 42%|58%	46% / 48%	45% / 52%
47	4mmL / 6mmL	62° / 63°	47° / 54°	32%|68% / 29%|71%	32% / 33%	54% / 54%
48	7mmL / 8mmL	64° / 59°	59° / 52°	55%|45% / 49%|51%	51% / 48%	28% / 32%
49	1mmL / 0mmL	61° / 60°	41° / 44°	43%|57% / 52%|48%	49% / 53%	42% / 66%
50	5mmL / 6mmL	47° / 51°	64° / 62°	66%|34% / 72%|28%	37% / 35%	32% / 34%

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