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Stabilization of the pelvis with the Hoffmann frame

An aid in diagnosing pelvic instability

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Pelvic instability is a controversial concept. The symptoms and signs are believed to be due to pelvic joint hypermobility. Differentiation from low back pain can often be difficult.

As an aid in diagnosis, temporary external fixation of the pelvis with a trapezoid compression frame was used in 12 patients. The effect on clinical signs and limping, tested on an electronic walkway, and symphyseal mobility has been analysed: in 11 of the 12 patients the frame had a positive clinical effect. In five of six patients limping diminished significantly. Stabilizing of symphyseal mobility could not be demonstrated.

Chronic pelvic instability is frequently used to characterize pain in one or more pelvic joints (the symphysis or the sacroiliac joints) caused by an increased mobility (Tönnis et al. 1970, Coventry & Tapper 1972, Neumann 1977, Tanaka 1981). It is thought that increased mobility may be caused by: trauma (Räf 1966, Kamhin et al. 1980, Pennal & Massiah 1980) or hormonal factors especially pregnancy – parturition (Dihlmann 1978).

Symptoms of pelvic instability may in many respects resemble those of low-back pain and sciatica, rendering the differential diagnosis more difficult (LaBan et al. 1978). Besides direct tenderness over the pelvic joints where the pain is located (Bucholz 1981), the straight-leg raising test (Lasègue's test) and Trendelenburg's sign are frequently positive (Hagen 1974, Grieve 1976).

A number of tests have been introduced which are believed to provoke movements – and thus pain – in the pelvic joints, especially in the sacroiliac joints (Cyriax 1982).

As a sign of pelvic instability, most authors refer to an increase in vertical symphyseal mobility. Chamberlain (1930, 1932) introduced a method by which vertical symphyseal mobility could be measured radiographically. The upper normal value was put at 2 mm.

One of the most common treatments for pelvic instability is a stabilizing sacroiliac belt. Pain is relieved and this is regarded as a confirmation of the diagnosis (Sahlstrand 1980). A more stable external fixation is obtained by various frame systems used nowadays for pelvic fractures. Some authors have suggested the Hoffmann frame and different models have been tested (Brown et al. 1982). Slätis & Karaharju (1975, 1980) found that a trapezoid compression frame gave the best stabilizing effect. When tightened it acts as a pair of tongs. Mears & Fu (1980) also mentioned that the pins inserted through the skin into the pelvis could very well serve as levers in reduction manoeuvres.

The aim of this study was to analyse the effect of temporary external fixation of the pelvic joints in patients with suspected pelvic instability, with a view to assessing its value as a corroborative diagnostic aid and possibly also in predicting the effect of pelvic arthrodesis. The trapezoid compression frame was chosen for this investigation.

Patients and methods

The series comprised 12 patients, one man and 11 women, who were referred to the Department of Orthopaedic Surgery, Karolinska Hospital, with clinical signs of pelvic instability.

The man, aged 31 years, had suffered pain ever since the occurrence of pelvic fractures 5 years before.

The 11 women were aged between 20 and 54 years (mean 34 years). One woman had residual pain following pelvic fractures. Eight women had pain following childbirth. *In three of the women the cause of pain could not be established.* The women had had pain for between 1 and 16 years (mean 6 years).

All patients had pain in the area of one or both sacroiliac (SI) joints, ten in the region of the symphysis or the groin and 11 had sciatica-like pain. Eight patients had *noted crepitations* in the pelvis and three patients had *experienced a locking sensation* in one of the sacroiliac joints. The discomfort was provoked by sitting or standing in one position, by walking, particularly on stairs, and also by other forms of physical exertion. In nine patients the pain was associated with limping and six walked with a stick, constantly or periodically. Nine patients obtained at least some relief from using a sacroiliac belt.

All patients experienced tenderness across one or both sacroiliac joints on palpation, and eight across the area of the symphysis and/or the groin. Compression of the anterior iliac spines caused pain in the SI-region in three patients, a sensation of relief in a fourth, while two patients also felt pain in the symphyseal region. Passive abduction of flexed hips provoked pain in the SI-region in ten patients and in the symphyseal/inguinal region in seven. Active straight-leg raising in the supine position, alternating the left and right leg, provoked pain in the SI-region in seven patients and in the symphyseal region in one patient. Rocking the sacrum by pressure at its inferior end, with the patient in the prone position, caused pain in the SI-region in three patients.

Trendelenburg's test was positive in two patients and elicited pain in the SI-region in eight patients. The straight-leg raising test (Lasègue's test) was positive to a moderate degree in nine patients, and a slight weakening of the foot/toe extensors was noted in two patients. The man who had had a pelvic injury associated with fractures of the transverse processes of LIV and LV, had slight quadriceps paresis.

The radiographs of the symphysis in the man and the woman with a history of trauma showed changes of the bone structure and osteophytes, and both revealed a difference in the level of the pubic bones (1 and 2 cm, respectively). One woman also had widening and erosions of the symphysis. In five patients Chamberlain's radiographic technique (1930), with the patient standing on alternate legs, revealed vertical symphyseal mobility exceeding 2 mm (3–10 mm). The two trauma patients also had radiographic changes, including slight widening, in the SI-joints. In a further six patients slight sclerosis and erosion of these joints could be seen.

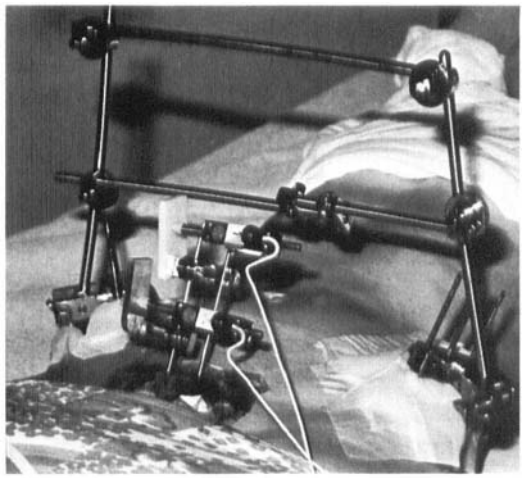

Figure 1. Electro-mechanical registration of symphyseal mobility in a patient with a Hoffmann frame (mounted as a trapezoid compression frame).

The 12 patients were analysed both before and after external fixation of the pelvis with a Hoffmann frame, mounted as a trapezoid compression frame (Slätis & Karaharju 1975) (Figure 1). The instrument was usually removed after 5 days. Two patients, however, at their own request wore the Hoffmann frame for 6 and 10 weeks, respectively. Both pre-and post-fixation analysis in most cases included a) clinical findings, b) degree of limping and c) symphyseal mobility.

After application of the Hoffmann frame, all patients were re-examined with respect to subjective symptoms and objective findings as in the pre-fixation clinical study, except for the sacral rocking test and radiologic assessment.

In 11 patients before and ten also after application of the Hoffmann frame, gait analysis was performed using an electronic walkway, previously described by Rydell (1966) and Collert (1974). Collert showed that the relation between the single limb support phase (SLS) on the left and the right side was only slightly influenced by cadence when the patient did not use a cane. As this ratio, easily measured on the walkway diagram, was considered to be a reliable variable also for the assessment of weight-bearing capacity and, consequently, the degree of limping, it has been utilized in this investigation. The ratio SLS left/right was calculated from the mean values of 6–12 steps and the speed of gait was disregarded. No patient used a cane during the walking tests.

In ten patients symphyseal mobility was mea-

Table 1. Effect of Hoffmann's frame on symptoms in 12 patients with pelvic instability

Effect on symptoms	Pain				Crepitation	Limp
	Sacroiliac joint n=12	Symphysis n= 9	Groin n=10	Sciatica n=11	n=8	n=10
Improved	10	6	7	8	8	9
Worse	0	0	0	1	0	0
None	1	3	2	2	0	0
Debut	1	0	1	0	0	1

sured without and with the Hoffmann frame with an electromechanical method (Walheim 1980). Transverse translation and rotation in the frontal plane were provoked by passive abduction of the flexed hip joints. Vertical translation was provoked with the patient in a recumbent position, actively lifting alternate legs, followed by standing on alternate legs. Sagittal translation and rotation in the sagittal plane were provoked only by standing on alternate legs.

Results

After application of the Hoffmann frame, all subjective symptoms either decreased considerably or disappeared in six patients and at least half of the symptoms in five more patients (Table 1). One patient became worse and also developed pain in the SI-joint which previously had not given any symptoms.

In one of the 11 patients whose existing symptoms improved, moderate pain instead developed in the symphyseal/inguinal region and in one more patient bilateral sciatica was accentuated. Despite this, the latter patient considered herself to be "much, much improved". Most of the patients also found that they could move better with the Hoffmann frame. The two patients who, at their own request, wore the frame for 6 and 10 weeks, respectively, had very moderate discomfort but at the end of the period suffered pain from the insertion sites in the iliac crests. About a month after removal of the frame, both patients experienced almost the same discomfort as previously.

After external fixation, all the objective findings were less marked or had disappeared in two patients and at least half of the findings in eight more patients. The pain in the SI-region which had affected ten patients, either became less or disappeared in eight. In one patient abduction no longer provoked pain in the left groin, but pain was still felt in the left SI-joint. Trendelenburg's sign which earlier had been positive in two patients was now negative and was less painful in eight. In six of nine patients the straight-leg raising test showed improvement.

Two of the ten improved patients developed moderate pain on palpation or provoked pain in the symphyseal/inguinal area; one of them in addition had a positive straight-leg raising test and slightly impaired sensibility along the back of the left foot. One patient had become worse both with regard to subjective symptoms and objective findings, including a positive Trendelenburg's sign associated with pain.

Table 2. Effect of the Hoffmann frame on limping, tested on an electronic walk-way (Rydell 1966)

Patient no.	Sex	Less limping subjectively	Ratio SLS left/right (mean values)		P-value (Mann-Whitney U-test)
			without frame	with frame	
1	F	+	0.86	0.97	0.01
2	F	+	0.84	0.95	ns
3	F		–	–	–
4	F	+	1.04	1.02	ns
5	F		0.99	0.93	ns
6	F	+	0.76	0.96	0.003
7	F	+	0.65	0.91	0.002
8	M	**	0.83	0.93	0.002
9	F	+	0.88	0.95	0.025
10*	F	+	1.0	–	–
11*	F	+	0.98	1.0	ns
12*	F	+	1.05	1.0	ns

* Bilateral sacroiliac pain.
** No limping subjectively.

By moving the sagittal bars, after removal of the transverse bars of the frame in five patients, the pain in the pelvic joints could be reproduced.

The ratios SLS left/right without and with the Hoffmann frame are presented in Table 2.

Without the Hoffmann frame, five of 11 tested patients had an almost normal ratio, i.e. 0.9–1.1. However, three of these five patients had bilateral symptoms.

The Hoffmann frame improved the ratio significantly in five of ten tested patients, i.e. it approached 1.0.

Symphyseal mobility was measured in 10 patients before and after the Hoffmann frame had been applied. In all patients, without the frame, translations in the transverse and sagittal directions were around or below 3 mm and rotations in the corresponding planes were around or below 1.5 degrees. In nine patients translations in the vertical direction were below 4 mm (range 0.3–3.9) in both provocative tests (lifting alternate legs in the supine position, and standing on alternate legs). In one patient it was 7 mm. Comparing the two tests, the difference in vertical translation exceeded 1 mm in only one patient (1.6 mm).

No stabilizing effect of the Hoffmann frame could be registered. With the frame, sagittal translation decreased by 1.7 mm in one patient; for the rest, no translation in any direction or rotation in any plane diminished by more than 1 mm or 0.5 degrees, respectively.

Discussion

In a material comprising 6895 patients with various back disorders, Solonen (1957) found 241 patients (3.5 per cent) with pain considered to originate from the sacroiliac joint. Berezin (1954) found "pelvic insufficiency after parturition" in almost 3 pro mille in a series of patients. Suspected, chronic pelvic instability following trauma is not unusual either. Räf (1966) found in his follow-up study that of 65 patients with double fractures of the pelvic ring, 30 had residual back pain. Slätis & Huittinen (1972) found residual back pain in 11 of 65 patients and Ahlers et al. (1980) residual SI-joint pain in 32 of 45 patients with pelvic injuries, in the latter series despite the absence of SI-joint radiographic changes.

Despite diminishing pain and improved function resulting from a sacroiliac belt, patients may have residual disability. In these cases symphysiodesis (Hagen 1974, Harris 1974, Olerud & Grevsten 1974) and/or arthrodesis of the SI-joints (Smith-Petersen & Rogers 1926, Metz 1970, Lie 1979) are recommended. Campbell (1980), on the other hand, believes that there is seldom any indication for these operations.

The present material consisted of 12 patients whose clinical picture satisfied the criteria for pelvic instability. However, in only one patient could a clearly increased vertical symphyseal mobility (7 mm) be recorded during standing on alternate legs. In all other patients this mobility was less than 3 mm. The patients' history revealed that nine had at least some relief of pain from the sacroiliac belt. Several of them, however, had experienced tenderness from local pressure across the sacroiliac joints and paresthesia along the outside of the thights after wearing the belt for a longer period. Before resorting to arthrodesis of one or several joints, additional tests were made after the application of a Hoffmann frame.

An advantage of the Hoffmann frame is that its firm bony anchorage allows provocation of direct motion of the pelvic halves in relation to each other and consequently is a more reliable diagnostic tool than manipulative indirect methods.

In 11 of the 12 patients a positive effect of this external fixation was noted in the clinical analysis. The pain-relieving effect was particularly marked in the SI-joint region (in nine of the 12 patients), while six of nine patients also reported less pain in the symphyseal region.

In the gait analysis all but one of the patients with an objectively recorded limp showed improvement after Hoffmann external fixation. These results consequently confirmed the clinical finding.

Additional verification of the specific diagnostic value of the Hoffmann frame in pelvic instability, by testing a control series of patients with low back pain and sciatica with the

frame, is incompatible with medical ethics. It would also be unethical to recommend the Hoffmann frame for treatment, as there is no evidence of any persisting therapeutic effect. The two patients who at their own request used the frame for a longer time, had at least a partial relapse about a month after its removal.

As regards vertical mobility at the symphysis, the individual results of electromechanical measurement showed good accordance on comparison of the provocative test in the standing with that in the supine position. Thus, it should be possible to use the latter test also for radiologic measurement of vertical symphyseal motion in patients whose pain prohibits standing on one leg.

The mobility of the SI-joints was not investigated. Nevertheless, the results of this study suggest that the pain in pelvic instability does originate in these joints since Hoffmann fixation of the pelvis provided satisfactory relief of pain and improved function, despite the lack of evidence of decreased symphyseal mobility. This undoubtedly suggests that some kind of stabilizing effect on the SI-joints and a Hoffmann frame can be recommended as a diagnostic aid in patients with suspected pelvic instability.

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