Role of Knight Brace in the Treatment of Spinal Instability

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ABSTRACT : One hundred and thirty-five patients who fulfilled the modified Eisenstein and Parry's dignostic criteria for spinal instability were studied. They were all underwent a Knight bracing program at least 3 months. Hydrotherapy was started 6 weeks after the bracing. It was found that the Knight brace was effective in the relief of back pain, extension and flexion, pain as well as sitting in tolerance. However, it was not very effective for the relief of spinal claudication and the improvement in the straight leg raising and neurological deficit.

INTRODUCTION

Spinal instability, by definition is said to exist when a lumbar motion segment exhibits abnormal movement, either in quality or quantity[1]. In clinical terms; however, the instability is more complex to define. We define the spinal instability by a set of criteria that is modified from Eisenstein and Parry[2]. (Table 1)

A prospective study was undertaken at our institution to define the place of a modified spinal orthosis in the management of patients with non-traumatic lumbar spinal instability. The attempt was to develop a comfortable brace which would be rigid enough to adequately support and immobilise the unstable lumbar spine, as well as being acceptable to most patients. In addition, we were trying to lay down appropriate guidelines as regards the duration and timing of bracing so as to ensure maximum patient compliance and to extract full therapeutic benefit from this modality of treatment.

TABLE 1
Clinical Diagnostic Criteria of Spinal Instability

1. Low Back Pain.
2. Increased in magnitude throughout the day.
3. Relieved by rest.
4. Pain on extension and/or flexion.
5. Swaying and jerky movement.
6. Sitting intolerance

MATERIALS AND METHODS

One hundred and sixty-seven patients who fulfilled the criteria mentioned above were included in the study. All these patients had low back pain which was relieved by rest and recumbency and increased in magnitude through day. Both flexion and extension of the spine caused the increasing pain and the normal flexion pattern was replaced by swaying, jerky movement. These patients demonstrated an intolerance to sitting for long period.

Patient Profile

Thirty-two patients were excluded from the study either from default or incomplete follow-up. Therefore, only 135 patients were analysed. The patients consisted of 48 males and 87 females. The age- range of the male patients was between 20 to 79 years with an average of 52 years. The female patients were aged between 25 to 76 years with an average age of 47 years.

Treatment Program

All patients had routine x-ray examination prior to the initiation of brace therapy.

The programme consisted of the use of a Knight's brace and 16 hours a day for 3 months. Six weeks after the patient had begun using the brace, hydrotherapy treatment was initiated three times a week. The hydrotherapy treatment continued till the end of 3 months. Since we anticipated problems with patient compliance, we laid down the criteria to define compliance towards the use of the brace in terms of hours per day of actual use.

The compliance of patients was graded as tabulated in Table 2.

TABLE 2
Classification of compliance

Compliance	Hours/day of actual use
Good	> 10
Fair	5-10
Poor	< 5

The Knight's Brace

This is a spinal orthosis designed to control the flexion-extension and the lateral bending of the lumbar spine. It derives its name due to its apperance, which resembles to an armour of a knight. We have to explain to every patient that it is not a "night brace" i.e. meant to be worn at night only. Rather, it is a Knight Brace, meant to be worn during the daily activities.

Design

The brace consists of 2 posterior uprights, made of aluminium alloy attached superiorly to a thoracic band and inferiorly to a pelvic band. These bands are made of aluminium alloy as well. An abdominal support is fastened to these metallic support . The abdominal support is fashioned from mouldable thermoplastic and extends from the sub-costal margins superiorly to the iliac crests on eithr side and up to the pubic symphysis inferiorly. To strengthen the entire system, oblique lateral uprights have been added, extending from the thoracic to the pelvic band (Figure 1).

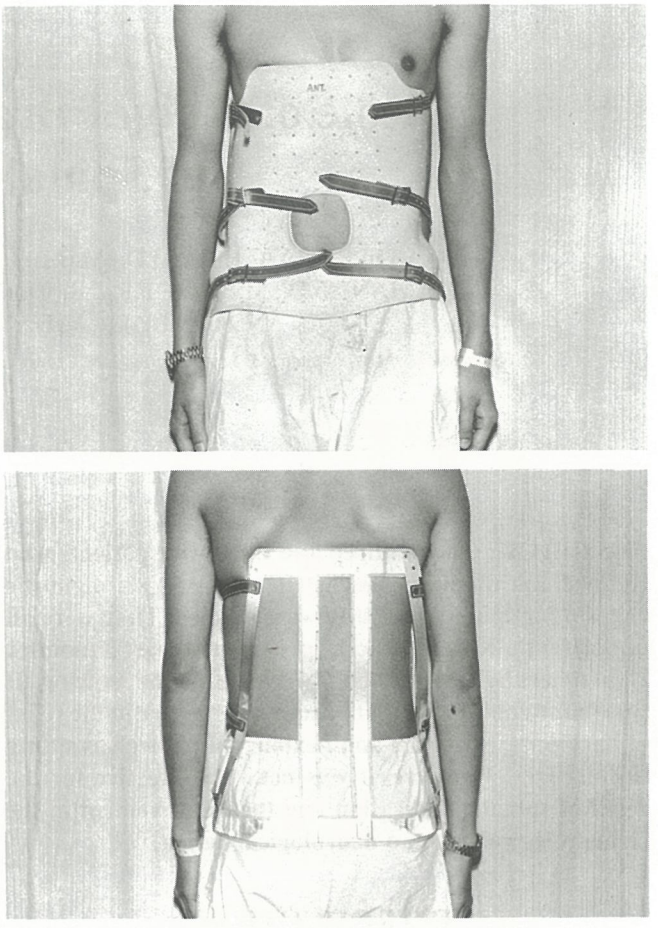

Fig 1. Appearance of the brace
(a) Front
(b) Back

Function

The brace provides a three point pressure system which limits extension in the lumbar spine. The lateral sides of the abdominal support provide medially directed forces which help restrict the lateral flexion of the lumbar spine. It also assists the abdominal musculature in maintaining the intraabdominal pressure which acts as a supportive mechanism for the lumbar spine. The brace helps to reduce excessive lumbar lordosis as well. Basically, the main function of the brace is to restrict the movement of extension of the lumbar spine which nearly always invokes pain in patients with the segmental instabilty. The fundamental hypothesis in using this bracing system is to help tide over patients from the symptomatic stage of the instability to the less symptomatic stage of stabilization

TABLE 3
Pre and post-treatment assessment

Time (in months)	Pain Score	Sciatica-Pain Score	Sitting Tolerance (in hours)	Claudication Time-level ground	No. of Patients with Pain on Extension	No. of Patients with Pain on Flexion
pre-treatment	5.8	4.2	0.37	0.42	125	101
1	4.5	2.9	0.48	0.51	92	82
2	2.9	2.1	0.56	0.48	70	71
3	2.2	2.3	1.21	0.41	59	62
4	2.4	3.0	0.73	0.40	62	55
5	2.8	2.7	0.70	0.45	89	70
6	2.9	2.5	0.85	0.47	97	79

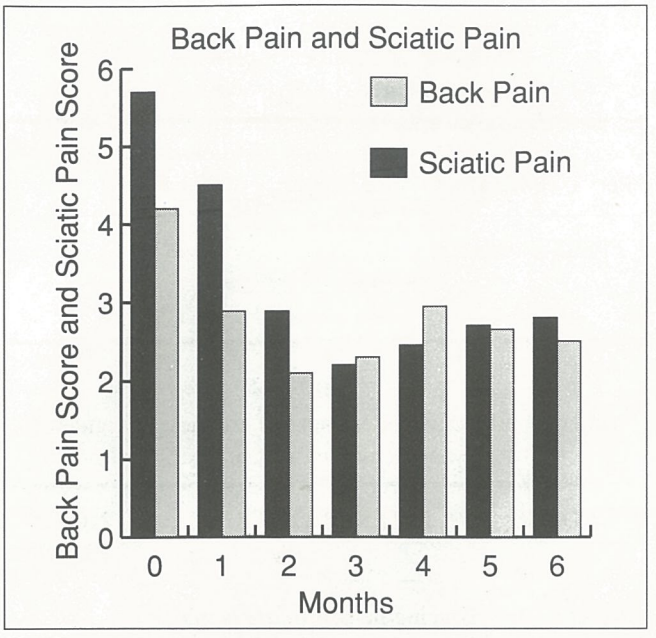

Fig 2. Change of back pain and sciatic pain score with time

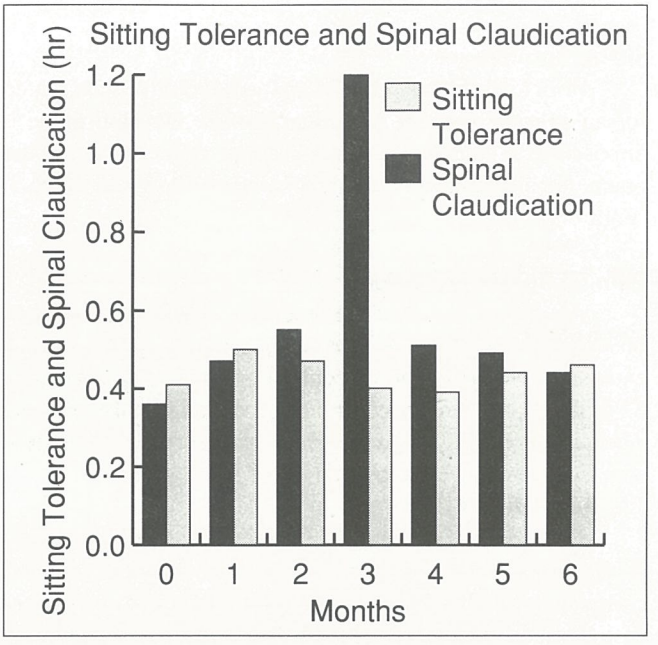

Fig 3. Change of sitting tolerance and spinal claudication with time

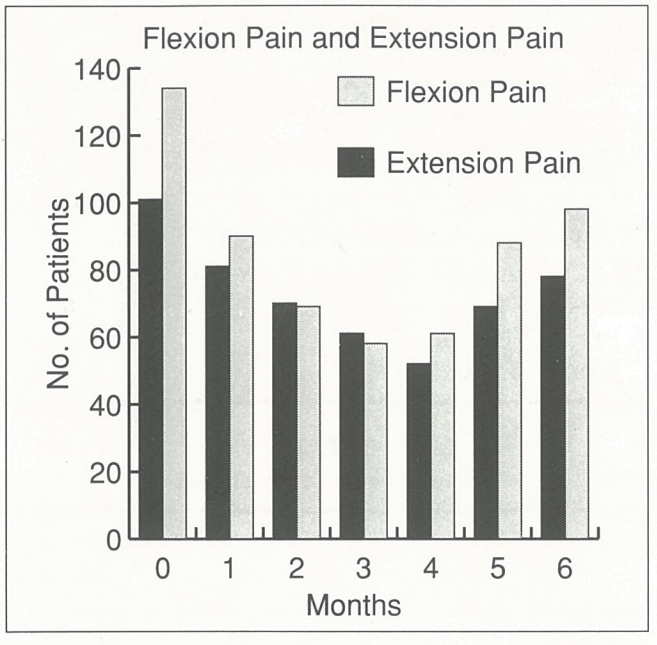

Fig 4. Change in number of patients having flexion pain and extension pain with time

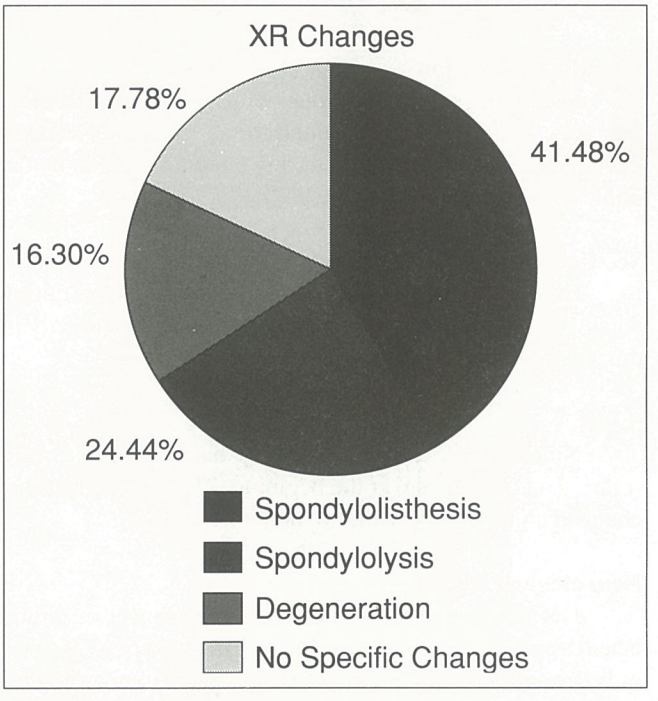

Fig 5. Distribution of the various x-ray findings

of the tissues[4]. This would evade the need to use surgical means (like fusion) to achieve the same ends.

RESULT

All patients were interviewed and examined at regular intervals over 6 months after the initiation of bracing and hydrotherapy. The results were compiled and tabulated under the following clinical parameters.

Back Pain

Patients were assigned a back pain score. A maximum of 10 points would denote intolerable pain while 0 points would denote absence of pain. These patients were asked to score their back pain during their monthly follow-up. Prior to the initiation of the treatment, the score of the group as a whole was 5.8. At monthly intervals, the average pain scores were shown in Table 3. (Figure 2)

Sitting Intolerance

Prior to the brace treatment, patients could remain seated for an average time of 0.37 hour, before the pain made it impossible to continue to remain seated. After the use of the brace, the sitting intolerance improved as shown in Table 3. (Figure 3)

Pain on Spinal Extension

After regular use of the brace for 3 months as many as 66% patients experienced significant control of pain on spinal extension. However, on discontinuing the use of the brace, 33% patients suffered a recurrence in pain on spinal extension. The number of patients experiencing pain on the spinal extension in 6 months was shown in Table 3. (Figure 4)

Flexion Induced Pain

One hundred and one of 135 patients had pain on flexion at the begining of the study. Thirty-nine of them reported complete relief from flexion related pain at the end of 3 months of treatment. Seventeen of them had recurrence of pain on flexion at the end of 6 months, 3 months after the cessation of bracing. (Table 3, Figure 4)

Spinal Claudication

Fifty-nine patients presented with neurogenic claudication after walking on level ground for an average 0.42 hour. The alteration of claudication during 6 months was shown in Table 3. (Figure 3)

Sciatic Pain

Only 39 patients complained of sciatica at the outset. Again, a 10 point scale was used to delineate the severity of this symptom. (Table 3, Figure 2)

S.L.R.

Nineteen patients in the study had impaired S.L.R. (more than 60 degress) at the begining. This finding was not changed significantly within 6 months. (Table 4)

Neurological Deficit

Decreased sensation, impaired motor power or diminished deep jerks were found in 26 cases in this series. Of these, only 3 improved and 3 others had inconsistent neurological fluctuation.

Subjective Patient Response

At the end of 3 months of treatment, patients were asked to qualify the benefit that they had experienced with the use of the Knight brace programme. The patients' dependency or subjective reliability on the brace was also assessed. (Table 5)

Complication

In the present series, we had encountered 4 cases of temporary lateral femoral cutaneous nerve problem which resolved with minor readjustment. There were 6 cases of hypersensitivity to the thermoplastics and they had to abandon the treatment program. There was no patient with chest complication or pressure sore as a result of the use of the brace.

TABLE 4
Change in the number of patients with impaired S.L.R. (< 60°)

Period (in months)	No. of Patients with impaired S.L.R.
Pre-Treatment	19
3	14
6	16

TABLE 5
Patients' subjective assessment of efficacy, dependency and compliance of brace

RESPONSE	INTERPRETATION	NO.OF PATIENTS
Good	Bracing helped tremendously	47
Fair	Bracing helped partially	34
Poor	Not helped by bracing	54
AT 6 MONTHS :		
Totally dependent on Brace	(> 10 hours/day)	22
Partially Dependent on Brace	(5-10 hours/day)	31
Minimally Dependant on Brace	(< 5 hours/day)	27
Independent of Brace		65
COMPLIANCE WITH PROTOCOL OF BRACING AND HYDROTHERAPY :		
Good	(10-15 hours/day)	65
Fair	(5-10 hours/day)	37
Poor	(< 5 hours/day)	33

TABLE 6
Breakdown of X-ray changes

X-Ray Picture	No. of Patients
Spondylolisthesis	56
Grade 1	39
Grade 2	12
Grade 3	3
Grade 4	2
Spondylolysis	33
Degenerative Changes, Traction spur	22
No Specific Finding	24

X-rays Finding

Patients in this series presented with a wide variety of radiological changes. (Table 6, Figure 5. However, the radiological picture did not influence our decision to include or exclude any patient from the protocol. The decision of bracing was based purely on the clinical criteria as already outlined at the beginning of the paper.

DISCUSSION

The authors would like to emphasize that the Knight bracing program is not introduced for any patient with low back pain. Instead, it is a specific modality for patients suffering from the instability of the lumbar spine. Hence, the accurate diagnosis of the spinal instability is essential for the success of such program. The diagnosis of the spinal instability rests on careful clinical evaluation and meticulous examination of the x-rays. At times, the flexion and the extension views of the lumbar spine are required to further substantiate the presence of instability. We had been very careful to explain to the patients that the brace is just a temporizing measure to tide them over the acute phase and they should wean it off as soon as they do not need it any longer. This is particularly important because we found that brace dependency or even addiction is a major problem in about 1/3 of the cases.

There was a definite improvement in the average back pain scores of patients using the brace. Moreover, on discontinuing the bracing programme at the end of 3 months, the back pain became slightly worse than before stopping. This clearly indicates the therapeutic benefit derived from the bracing in patients with the spinal instability.

The sitting tolerance time of patients showed a distinct improvement, up to three folds in some cases. After discontinuation of the use of the brace for support, the patients reverted back to higher levels of intolerance to sitting, quite similar, albeit slightly better than pre-treatment levels.

As many as 66% patients experienced full relief from pain on the extension and about 50% had relief from the pain on the flexion. On subsequent discontinuation of the use of the brace, about half of these patients had a recurrence of pain. This leads us to believe that the therapeutic benefit provided by the brace is of immense value in relieving the movement related pain in these patients.

The spinal claudication did not appear to benefit significantly by the bracing protocol.

The bracing gave some relief from the sciatic pain in this group of patients. However, it was not a dependable modality of treatment in providing improvement in the straight leg raising test. Patients with motor or sensory loss do not recover this loss by the use of the brace.

Subjectively, 35% of the patients felt that the bracing had helped them to a very great extent. Twenty-four percent felt that the use of the brace had helped them partly in controlling their problems while the remaining 40% patients felt that the bracing was of no help whatsoever. Thus, 60% of the subjects of this study felt that the brace provided them with a reasonable therapeutic option. This was an acceptable modality of treatment that had helped them tide over the possibility of having to undergo a surgical stabilization.

After 6 months of using the brace, as many as 40% patients were totally or partly dependent on the brace, that is to say that they were using the brace for up to 10 or more hours a day. Fourty-eight percent of the subjects were independent of the brace at 6 months. This dependency reflects the stabilizing function of this brace in patients with the definite clinical spinal instability. Nevertheless, we are aware of the detrimental effect of immobilize the spine namely, weakening of the spine musculature[5]. We categorically mentioned the importance of substituting, the stabilizing effect of the brace by strengthening of the back and abdominal muscles.

In terms of the actual use of the brace in hours per day, there appears to be a high degree of acceptability on a part of the patients. Twenty-four percent subjects used the brace for 5 hours or less per day , which was defined as poor compliance. Majority of the patients (76%) used the brace for 10 or more hours a day. Thus, it was evident that the brace was well accepted by patients and user compliance was not a major problem.

This bracing system has basically been used to immobilize and support the unstable lumbar spine as suggested by Sypert[6]. In addition, it limits certain movements and positions of the spine which induce pain.

The problems of weakening of axial muscles and soft tissue contractures[5] were not encountered in our patients. This was related to the fact that all patients were underwent appropriate hydrotherapy treatment during their usages of braces.

Some workers[7,8] have reported that the use of the lumbosacral orthrosis might aggravate patient's symptoms by the stress and movement at either end of the immobilized segments. They suggested that this could be overcome by attaching a thigh extension. However, in practice, none of our patients experienced worsening of symptoms which could be attributed to the use of the brace. Thus, we found that this type of brace is useful modality of treatment and serves as a viable alternative to surgical intervention in patients with the lumbar segmental spinal instability. Furthermore, we found that this bracing protocol could act as a good prognosticating indicator to select patients who would require a surgical fusion.

In conclusion, we found that the Knight brace is a very useful modality in the conservative armarentarium for the treatment of the low back pain provided that it is used for a specific indication and is weaned off at the appropriate time substituting it with the back and abdominal muscle strengthening.

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