"Acute and Chronic Effects of Pneumatic Lumbar Support on Muscular Strength, Flexibility, and Functional Impairment Index" - emphasizes the acceleration of gain of flexibility, pain management strength and ultimate return to work, compared to a control group.

REHABILITATION STUDY

TITLE: "Acute and Chronic Effects of Pneumatic Lumbar Support on Muscular Strength, Flexibility and Functional Impairment Index"
AUTHOR: Keith W. Penrose, Ph.D., Kumkay Chook, M.D., John L. Stump, D.C., MS Sports Medicine
SUMMARY: Subjects in the treatment and control groups are matched according to gender, grade of strain/sprain by an orthopedic-neurologic examination. Gain scores were analyzed and those utilizing the Air Belt™ were found to have substantial improvements in flexibility, strength, and reduction of pain perceived. In functionally impaired individuals, the use of Air Belt™ facilitated a quicker return to normal daily activity.

ACUTE AND CHRONIC EFFECTS OF PNEUMATIC LUMBAR SUPPORT ON MUSCULAR STRENGTH, FLEXIBILITY, AND FUNCTIONAL IMPAIRMENT INDEX

KEITH W. PENROSE, KUMKAY CHOOK, and JOHN L. STUMP
Preventative and Rehabilitative Services, Mobile, Alabama 36609, USA
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This research project was designed to assess the causal influence of wearing an "air belt" (pneumatic lumbar support) on the development of muscular strength, hip and back flexibility, and a functional impairment (pain) index. Thirty subjects were randomly selected from a pool of individuals who were diagnosed as having muscular strain/sprain of the lower back by an orthopedic-neurologic examination. They were graded as mild, moderate, or severe. Subjects in the treatment and control groups were matched according to gender and grade of strain/sprain. Each subject was tested initially, again after 1 hour, 3 weeks into the program, and finally post-tested after 6 weeks of therapy or control. Subjects in the treatment group were required to wear the air belt for 1 hour after a pretest, then for 6 hours a day, 5 days a week for the 6 weeks of rehabilitation. Gain scores were analyzed using an analysis of covariance (ANCOVA) with age and pain as the covariates, p £ 0.05. Muscular strength improved 4.9% after wearing the air belt for 1 hour, 11.5% after 3 weeks, and 16.1% after 6 weeks of use. Since these individuals were functionally impaired as a result of lower back sprain/strain, the air belt does appear to improve substantially the strength otherwise lost due to a lower back injury. The ANCOVA tests for flexibility and pain index gain scores at acute, midchronic, and chronic stages of testing and therapy were all found to be significant. Therefore, it may be concluded that use of the air belt aids in flexibility and lessens the pain perceived in functionally impaired individuals. Subjective assessment of pain decreased by 18% after 1 hour of air belt use, 46% after 3 weeks of use, and 73% after 6 weeks of use. Flexibility improved 35%, 70%, and 93% during the same period. These results indicate how use of the air belt may lessen the pain associated with low-back injury and may help increase strength and flexibility, thus facilitating a return to normal daily activity.
KEYWORDS: air belt, low back strain/sprain, strength, flexibility, functional impairment (pain) index

INTRODUCTION

It is generally accepted that low-back pain is one of the most common complaints of workers and active individuals in all walks of life. Epidemiology statistics estimate that 5.4 million Americans are affected at a cost of 16 billion dollars annually to the economy. In addition, untold chronic suffering is associated with this disabling condition (Gilbert, 1982; Sarno, 1986). Low-back pain leading to absenteeism from work, low productivity, and workman's compensation payments could be devastating to industry. The tremendous impact back pain has on the American workers in their most productive years is staggering (Mayer, 1983; Morris and Randolph, 1984; U.S. Dept. of Labor, 1982).

Muscle spasm is considered to be a primary source of pain arising from injury of the lower back (Keim and Kirkaldy-Willis, 1980: Mooney. 1983: Sarno. 1978: U S. Dept. of Labor. 1982: Wyke. 1980). As a result, it is thought to play an important role in most back sprains or strains. The common treatment for lower back sprain/strain type injures traditionally has been bed rest and medication (Sarno. 1986; Wiesel et al., 1984): however, this form of therapy may not be the treatment of choice, since medication is expensive and not without risk and most individuals cannot afford to take time off to stay in bed. Therefore, it seems plausible to search for and develop alternative methods of therapy for this type of injury.

This study was designed to assess the influence of wearing an 'air belt" (pneumatic lumbar support) for relief from functional impairment (pain) and consequently on the redevelopment of muscular strength, hip and back flexibility.

PROCEDURES

Thirty subjects were randomly selected from a pool of individuals diagnosed with muscular sprain/strain of the lower back by an orthopedic-neurologic examination on which they were graded as mildly, moderately, or severely injured (Hoppenfeld, 1976). From the pool, a subject was randomly assigned to one group and another was randomly selected from the pool according to gender and grade of sprain/strain to match the former. This process was repeated until the matched groups had 15 subjects each. These groups were randomly assigned to an air belt group or a matched control group. Neither investigators nor subjects knew which of the groups was selected for the air belt group or the matched control group until after all assignments were made. All subjects signed an informed consent form before participation.

The rehabilitation program lasted a total of 6 weeks. Subjects in the treatment group were required to wear the air belt for 1 hour after a pretest, then for 6 hours a day, 5 days a week for 6 weeks (Fig. 1). Each subject was tested initially, again after 1 hour, after 3 weeks into the rehabilitation program and finally after 6 weeks of rehabilitation for changes in muscular strength, flexibility, and on a subjective pain index. The subjects were tested for these measures in a random order with a subject from one group being tested followed by a matched counterpart. The air belt was not worn by the members of the experimental group while being tested for strength, flexibility, or pain. All subjects were encouraged to exert maximal effort for the strength and flexibility tests.

Static muscular strength was measured using a hip, back, and chest dynamometer (J. A. Preston Corp.). With knees slightly bent, subjects stood on a metal plate and exerted an upward force while holding a handle attached to the dynamometer by a chain. The length of the handle to the dynamometer was adjusted for each subject to ensure maximal individual generation of force. The dynamometer measured strength in pounds of force generated. Calibration of the isometric dynamometer was performed prior to the strength measurements following manufacturer guidelines to ensure accuracy. A practice trial was performed to familiarize each subject with the apparatus prior to making two measured trials. One minute of rest between trials was allowed to prevent fatigue. Since the objective was to obtain a criterion score that represented the subjects' maximal performance, the peak measurement was used to represent muscular strength (Cochran and Cox, 1957). A test-retest reliability coefficient of the strength measurement was determined and reported for each group (Cochran and Cox, 1957; Thomas and Nelson, 1985).

FIGURE 1 Air belt worn by the experimental group.

Hip and back flexibility was determined using a sit-and-reach box graduated in inches (Borms, 1984; Frishberg et al., 1985; Jackson and Baker. 1986). Subjects were instructed to sit on the floor with their legs extended and their feet flat against the front edge of the box. They were then asked to lean forward, stretching their extended arms as far forward as possible. A practice trial was allowed each subject to familiarize them with the apparatus. Maximum length of hip flexion was measured to the nearest inch at the tip of the extended fingers for the two trials. The best score was recorded. A test-retest reliability coefficient was determined and reported for the flexibility score.

A functional impairment rating of each subject was measured from a questionnaire that elicited a patient history, the character of their pain, their degree of activity, and a subjective rating of the severity of their pain. The functional impairment scale was modified from that of Roland and Morris (1983). It has been reported by Roland and Morris (1983) that a functional impairment questionnaire is a reliable, reproducible, and practical guide to therapeutic efficacy.

An analysis of covariance (ANCOVA) procedure (Cochran and Cox, 1957; Thomas and Nelson, 1985) was used to analyze paired gain scores for muscular strength, flexibility, and the pain index at the time of pretest, acutely (1 hour), midway through the program (3 weeks), and at the termination of using the air belt (6 weeks). Between-group analyses differences and treatment differences (air belt vs. control) on all the tests were declared significant for p£ 0.05. Subject age was used as a covariate to analyze gains in strength, flexibility and pain index, and the pain index served as an additional covariate to determine its influence on strength and flexibility. Adjustments were made in the dependent variables to account for the variability due to the covariate.

RESULTS

The average ages of the air belt group and the control group were 32 and 37 years, respectively. Ages ranged in both groups from 19 to 61 years. There were four women and eleven men in each group.

The reliability coefficients for the test-retest measures of strength and flexibility were 0.96 and 0.97, respectively.

Air belt use improved muscular strength and flexibility expression in functionally impaired individuals with low back strain or sprain. Furthermore, subjective pain was perceived to be less in subjects who wore the air belt (Table I).

Improvement on all three dependent variables when adjusted for the covariate or age were significantly greater for the air belt vs. control group at the acute stage (1 hour) of wearing the air belt, as well as during the midchronic (3 weeks) and chronic (6 weeks) stages (Figs. 2-7). In addition, the increase in midchronic strength (air belt vs. control) was better than the acute increase and chronic strength improvement was better than that achieved at the midchronic stage. Midchronic flexibility improved significantly more than that shown in the acute stage: however, no further improvement in this variable was found between the midchronic and chronic stages. Concomitantly, pain perception lessened substantially from the acute to the midchronic stages, but the change in pain perception was not significant for the remainder of the study period. The covariate "age" was found to be a nonsignificant contributor in each of the tests for strength, flexibility, and pain index. This suggests that the variability of the test scores due to age of the subject is minimal and probably had little to do with the outcome.

Only in the measurement of the gain in strength from the pretest measurement to the chronic stage measurement and the gain in flexibility from the pretest to the acute stage measurement was pain a significant covariate. In all other cases, pain was nonsignificant and of no consequence. These findings were substantiated when an analysis of variance was performed on these same dependent variables. The air belt treatment group was found to have improved uniformly better on the variables measured.

TABLE I

Average gain scores and standard errors for the air belt and control groups on muscular strength, flexibility, and pain index measures.

	Acute (1 hour)	Midchronic (3 weeks)	Chronic (6 weeks)
Strength (lb)			
Air belt	$5.2^{+} \pm 1.4$	$12.7^{+} \pm 2.1$	$17.7^{+} \pm 2.8$
Control	0.1 ± 0.3	1.5 ± 0.3	2.7 ± 0.4
Flexibility (in.)			
Air belt	$0.8^{+} \pm 0.2$	$1.7^{+} \pm 0.2$	$2.1^{+} \pm 0.2$
Control	-0.1 ± 0.1	0.2 ± 0.1	0.5 ± 0.1
Pain index			
Air belt	$1.1^{+} \pm 0.3$	$3.2^{+} \pm 0.3$	$5.2^{+} \pm 0.4$
Control	-0.1 ± 0.1	0.9 ± 0.2	2.3 ± 0.3

^{+}p 0.05. Statistical analysis: ANCOVA

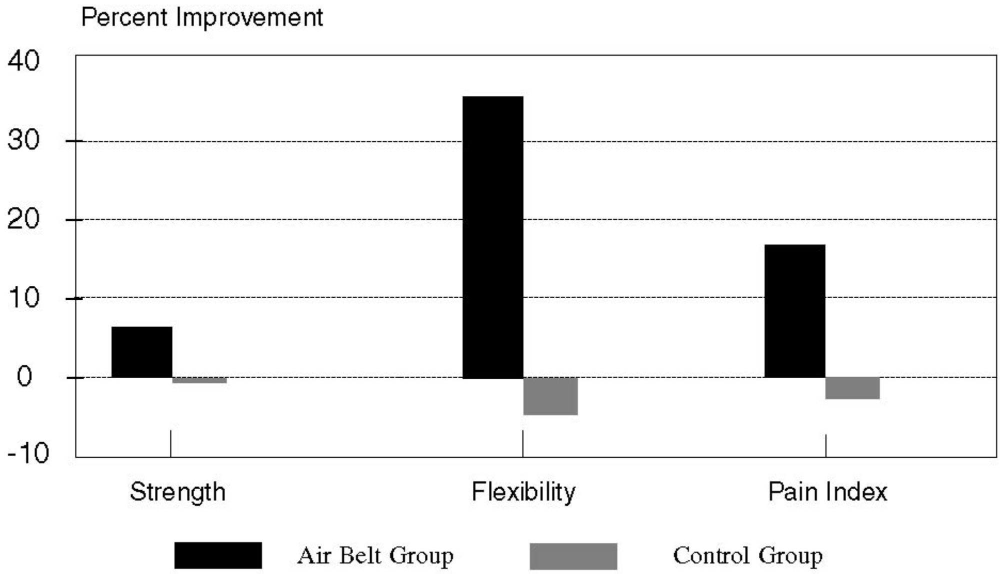

FIGURE 2 Changes from pretest to 1 hour.

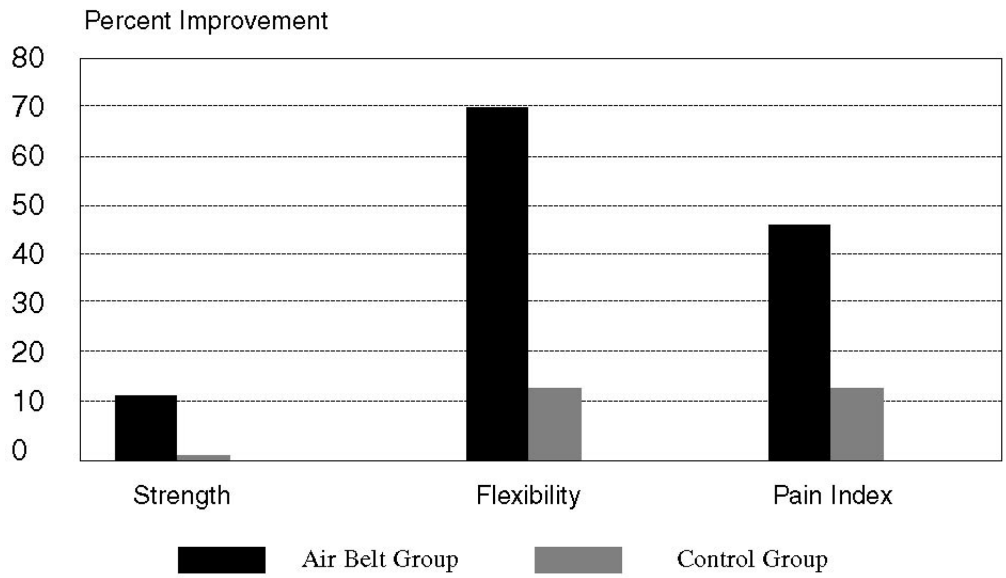

FIGURE 3 Changes from pretest to 3 weeks.

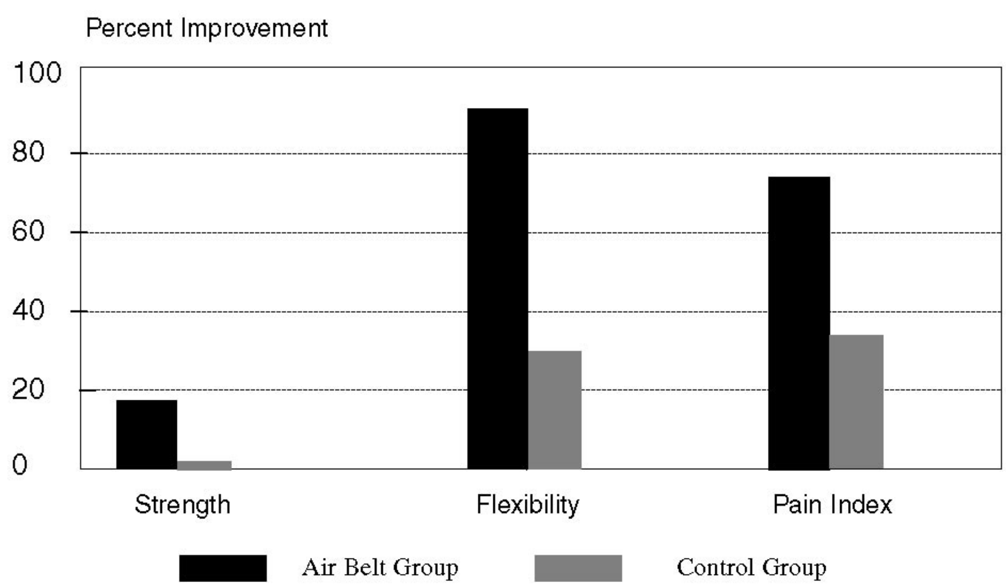

FIGURE 4 Changes from pretest to 6 weeks.

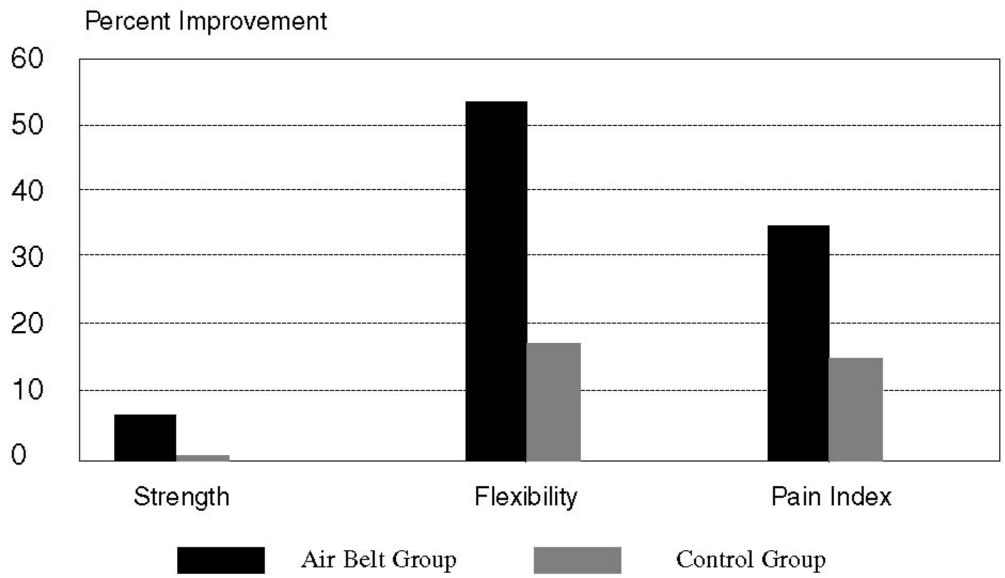

FIGURE 5 Changes from 1 hour to 3 weeks.

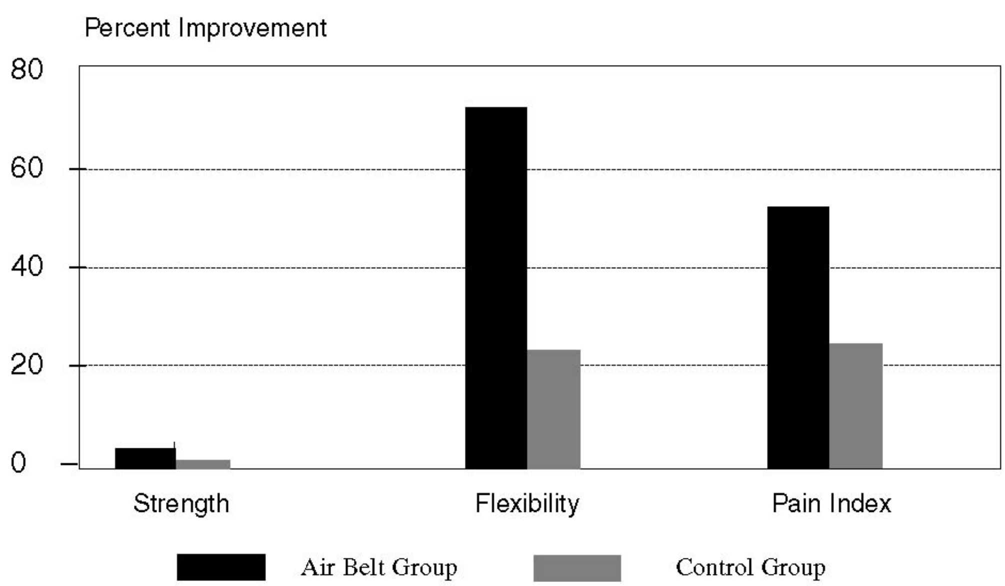

FIGURE 6 Changes from 1 hour to 6 weeks.

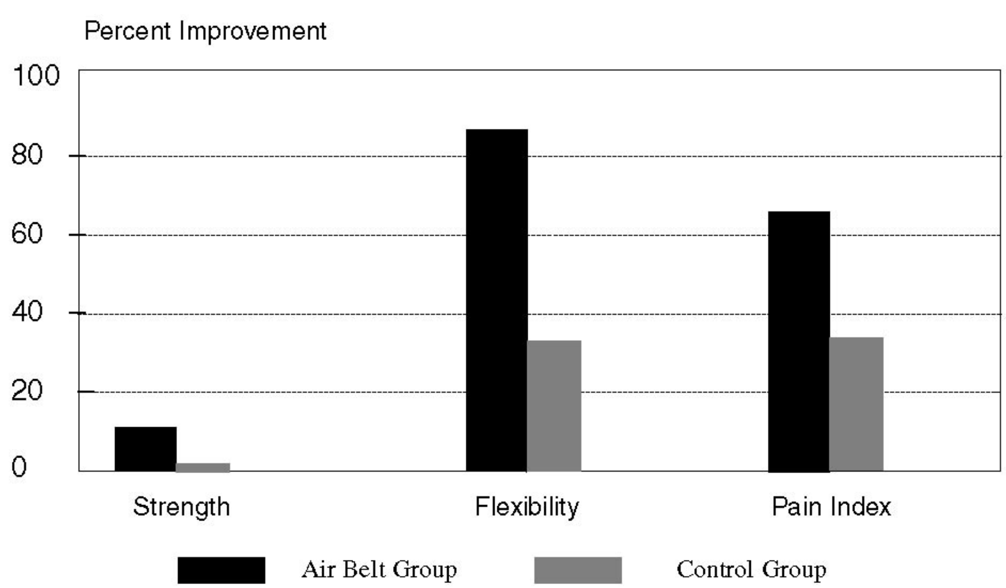

FIGURE 7 Changes from 3 weeks to 6 weeks.

DISCUSSION

The air belt is a uniquely designed lumbar support that may be comfortably worn without restriction of mobility for the wearer. Subjects had no difficulty wearing the device for the required time and some even wore the belt to bed without any discomfort. The inflated air pockets that line the inner posterior surface of the belt provide a continuous anterior to posterior pressure that initiates a static stretch to the longitudinally oriented erector spinae muscles while the osseous and ligamentous structures of the lumbar spine are supported.

Static stretch of muscle has been shown to be an effective means of alleviating myogenic pain (Allman, 1978; Beaulieu, 1981; Berger, 1952; deVries, 1960a. 1960b: McArdle et al., 1981) The results of the present study support these findings. The reduction of pain perceived by subjects wearing the air belts probably influenced improvement in the expression of muscular strength and flexibility. It is inconceivable to think that the air belt increases muscular strength in the conventional sense of increasing fiber size. However, since the subjects in the study are functionally impaired as a result of lower back strain/sprain, the findings appear to demonstrate that the air belt substantially improved the ability of each subject to regain the strength and flexibility lost due to a lower back injury.

The variability in age of subjects was found not to be significant when analyzing the dependent variables using age as the covariate. This observation leads us to believe that it was not necessary to match the subjects by age because the variability due to age was of no consequence. Expression of muscular strength improved; 5% after wearing the air belt for 1 hour, 12% after 3 weeks, and 16% after 6 weeks of use. The flexibility of treatment subjects also improved 35%, 70%, and 93%, respectively, at the same time points during the period. It was initially thought that changes in strength and flexibility may be due to the variability in the perception of pain at each test. However, the nonsignificant finding of pain as a covariate suggests that variability in the pain index between each test probably had little influence on the outcome of strength and flexibility changes. Nevertheless, whatever variability exists was accounted for.

The ANCOVA tests for flexibility and pain index changes in the acute, midchronic, and chronic stages were all found to be significantly improved. It may be concluded that the air belt improves flexibility and lessens the pain perceived due to spinal injury in functionally impaired individuals. However, both these dependent variables were found not to improve further beyond the 3-week (midchronic) stage. Studies regarding the natural history of low back pain indicate that 80% of patients improve within 6 weeks with or without treatment, and the remaining 20% are likely to have chronic pain for an extended period (Nachemson. 1983). Our results confirm this. Pain was relieved and flexibility increased in control subjects also, as time progressed. As a group, the control subjects perceived markedly less pain from midchronic stage (3 weeks) onward. However, the air belt group perceived less pain after 3 weeks than the controls did after 6 weeks. Therefore, it is important to point out that pain was relieved and flexibility improved quicker and to a greater extent in subjects who wore the air belt. Subjective pain decreased by 18% after 1 hour of air belt use, 46% after 3 weeks of use and 73% after 6 weeks of use.

These results lead us to believe that the therapeutic measure of wearing an air belt may contribute significantly to reattainment of the muscular strength and flexibility lost due to an injury of the lower back. The level of pain perceived from low-back sprain/strain also appears to be reduced. In addition, wearing an air belt may be a cost-effective treatment; decreasing the patient's perception of low-back pain, nullifying the need for costly medication and decreasing absenteeism from work. Success or failure of any mode of treatment for lower back injuries depends on a patient's ability to resume normal activity. The results of this study indicate that use of an air belt may lessen pain associated with low back injury and help increase expression of previous strength and flexibility, thus facilitating a return to normal daily activity.

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