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EARLIER VERTEBRAL COMPRESSION FRACTURES DETERIORATE DISABILITY AND QUALITY OF LIFE AFTER A SUBSEQUENT ACUTE FRACTURE

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INTRODUCTION

The vertebral compression fracture is one of the most common osteoporotic fractures {Chrischilles, 1991 #184}. Approximately 30-50% of the women and 20-30% of the men suffer at least one vertebral fracture during their lives and half of them will develop multiple fractures {Ross, 1997 #17}. The impact of the fracture on pain, daily activities and quality of life (QoL) has been poorly evaluated. When the natural course of the acute vertebral compression fracture was followed recently during a year its was shown that this fracture

resulted in a severe pain condition that with few exceptions lasted at least for a year, deteriorating both function (ADL=Activities of Daily Living) and quality of life (QoL) (2008, Suzuki A+B). In spite of this fracture's commonness the knowledge about the mechanisms causing the long lasting pain problem is limited.

Earlier it has been reported that the type of fracture had no impact on the pain {Ismail, 1999 #11} while location and grade of fracture deformity influenced upon the QoL or severity of pain {Cockerill, 2000 #12}{Silverman, 2001 #112}{Ryan, 1994 #96}. When followed prospectively it was found however that the degree of fracture deformation of the acute fracture was an important factor in deciding the prognosis of pain as well as disability and QoL (Suzuki 2008).

It is well known that not only the new vertebral compression fracture but the presence of previous fracture/fractures can modify the prognosis of a new fracture. The number of old fractures, old fracture location and old fracture severity all have been ascribed influences on pain, disability and QoL {Jinbayashi, 2002 #109}{Oleksik, 2000 #28}{Nevitt, 1998 #110}{Ross, 1991 #48}{Burger, 1997 #86}{Ettinger, 1992 #13}. The odds of impaired function were for example 1.4 times higher with one single vertebral deformity and 3.1 times with two or more deformities {Jinbayashi, 2002 #109}.

The presence of an old fracture has also been found to be a strong predictor for the occurrence of a subsequent incident fracture {Ross, 1993 #55}{Davis, 1999 #132}{Klotzbuecher, 2000 #214}{Black, 1999 #193}{Lunt, 2003 #196}. It has also been found that 19.2% of the women with an acute fracture will have a second one within one year and usually located near the old fracture something that might contribute to the bad prognosis {Rao, 2003 #21}{Lunt, 2003 #196}{Cockerill, 2000 #12}.

It seems reasonable to assume that the existence of an old fracture might explain some of the differences in prognosis of pain, disability and QOL seen in patients with an acute vertebral

fracture.

The aim of this study therefore was to evaluate how the presence of an old fracture, the number, location and closeness to the acute fracture will influence upon the prognosis of pain, disability, QoL and ADL after the incident vertebral compression fracture.

MATERIALS AND METHODS

All patients who were admitted to the emergency unit at Sahlgrenska University Hospital (Sahlgrenska and Mölndal) with a radiologically detectable acute vertebral compression fracture which resulted from a low energy, “every day” type of trauma and with an age over 40 years, were eligible for the study. The study was performed from December 2003 until November 2006.

Excluded were those with fracture/fractures related to malignancy, infection or any other bone disease, except osteoporosis, that could affect the mechanical integrity of the vertebrae in the lumbar or thoracic spines.

Within ten days after the visit to the hospital’s emergency unit, all eligible patients received written information about the study and an invitation to participate. The patients that agreed to participate received a first questionnaire at the latest 3 weeks after the fracture had been diagnosed and then after 3, 6 and 12 months. The questionnaires were self explanatory and intended to be used for postal surveys. The questionnaires described below were used in the study; all of the questionnaires were used at each of the four follow-up times.

Questionnaires

von Korff’s Pain Intensity and Disability Questionnaires

This instrument was designed and validated for use among patients outside the hospital setting. It includes 7 items with a 10-graded response possibility, ranging between “no pain” or “no functional restriction” to “worst pain ever” “or can do nothing”
{Von Korff, 1993 #50; Von Korff, 1992 #42}.

The Pain Intensity score is calculated as the average of 0-10 ratings of current pain, average pain and worst pain multiplied by 10 to yield a 0-100 score.

The Disability score is calculated as the average of three 0-10 interference ratings in daily, social and work activities multiplied by 10 to yield a 0-100 score.

Hannover ADL score

This questionnaire was developed for measuring back pain-related disability. It is a self-administered questionnaire consisting of 12 items which assess functional limitations in activities of daily living among patients with musculoskeletal disorders. The 12 items have to be scored, summed and transformed on to a scale from 0 (worst back function) to 100 (best back function {Kohlmann, 1996 #209}.

EQ-5D

This is a generic health-related quality of life measure. It provides a single index. The individuals classify their own health status into 5 dimensions: mobility, self-care, usual activity, pain/discomfort and anxiety/depression within three levels (i.e. no problems, moderate problems and severe problems). The instrument yields a total of 243 possible health states, and the Time Trade Off method is used to rate the different states of health. The value 0 indicates “dead” and 1 indicates “full health” {Dolan, 1996 #210}{Dolan, 1996 #211}. Negative values are possible and represent conditions worse than dead. In Sweden, the instrument has been validated on extensive cohorts of back pain patients and of ages similar to those expected in the present study {Burstrom, 2007 #151}.

Spinal radiographs

Lateral and frontal view radiographs of the spine were taken at the first visit to the hospital’s emergency unit. The presence of an acute fracture was primarily decided by the attending radiologist. For the purpose of the study, two experienced spine surgeons separately re-evaluated the radiographs. A fracture was considered acute when there was an evident

sharp edge in the compressed region and no callus formation was visible {Bengner, 1988 #92}.

In questionable cases, the presence of previous or subsequent examinations was used to confirm the acuteness. When MR images were available, this information also was used for determining if the fracture was fresh. Eight patients had their fresh fractures confirmed by previous X-rays, 27 patients by subsequent X-rays and 11 patients through MRI. In cases of divergent opinions, the cases were discussed and consensus reached.

Fracture type grade of deformation

Three osteoporotic fracture types -wedge, crush, and concave- have been described. The wedge fracture has a collapsed anterior border with an intact or almost intact posterior border. The crush fracture means a collapse of the entire vertebral body. Concave fracture shows collapse of the central portion of the vertebral body {Rao, 2003 #21}.

The grade of fracture deformation was evaluated by the semi quantitative method presented by Genant {Genant, 1993 #20; Genant, 2003 #38; Genant, 1996 #44}.

The extent of deformation was graded on visual inspection and without direct vertebral measurement as normal (grade 0), mildly deformed (grade 1, approximately 20-25% reduction in anterior, middle, and/or posterior height and a reduction of area 10 –20%), moderately deformed (grade 2, approximately 25-40% reduction in any height and a reduction in area 20-40%), and severely deformed (grade3, approximately 40% reduction in any height and area).

Post fracture mobilization

All the patients were mobilized as soon as possible and usually without casts or braces. If pain prevented from an immediate mobilization a soft brace was prescribed. Twelve of the patients used a soft brace for different lengths. Analgesics were usually prescribed and the advice to the patient was to try to resume as normal physical activity as possible as soon as

possible. The prognosis told was that pain would disappear within weeks to some months. If continuing problems, the patients were recommended contact with their General Practitioners.

Preventive treatment

Fourteen of the 107 patients reported that they during the year before the actual fracture had medicated in order to increase their bone mineral.

Statistical analysis

All the data was entered and analysed with the SPSS 14 statistical analysis programme for Windows.

Parametric tests, independent or paired t-test were used for analysing difference between groups of parametric scale variables. Nominal variables were tested by the Chi-square test. For comparison of repeated measurements, repeated ANOVA was used. If the repeated ANOVA was significant, the Bonferroni /Dunn procedure was used as a post hoc test.

Pair wise associations were examined by Pearson correlation coefficient test when the data were on a continuous scale.

All tests were two-sided. The results were considered to be significant at $P < 0.05$.

Ethical approval

The study was ethically approved by the Research Ethical Committee of the Medical Faculty, Gothenburg University, 17th June 2003 (S 270-03).

RESULTS

The study population

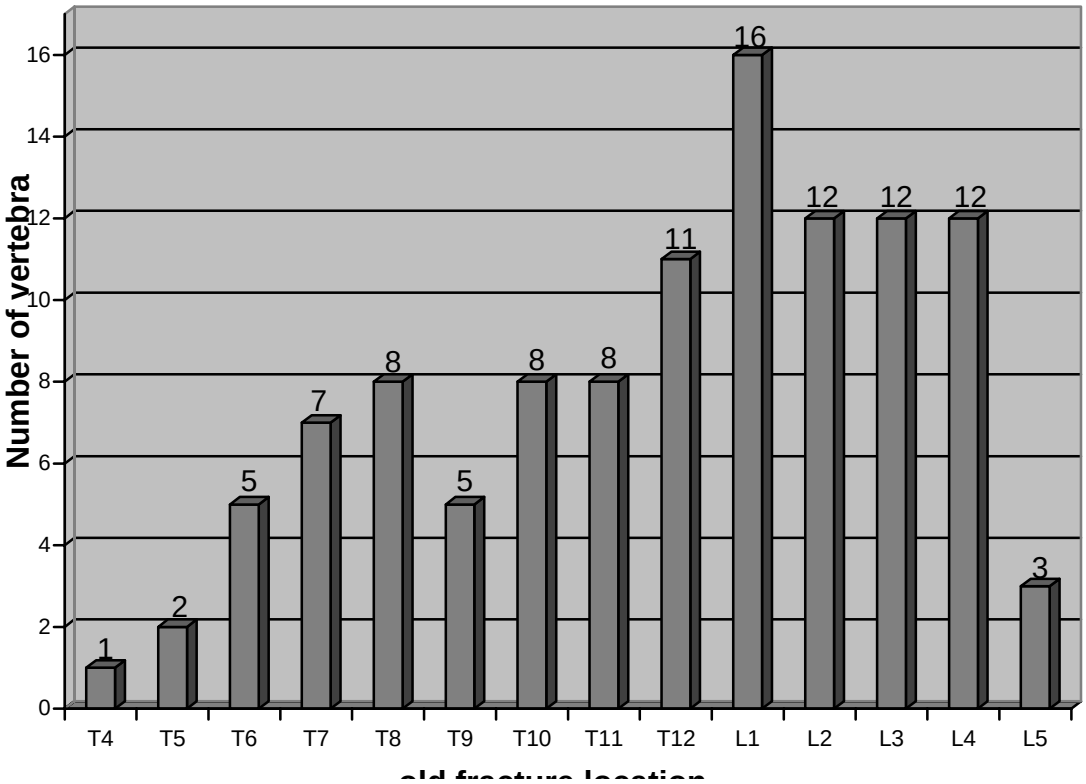
The study population has been described in detail elsewhere (2008, Suzuki). A total of 107 patients with an acute compression fracture were followed for one year. Fifty one (47.7%) patients had at least one old compression fracture, while 56 (52.3%) patients had no old fracture. The average age of the patients was 75.5 years old (SD 11.9), 77.7 years for those

with an old fracture and 73.5 years for those without (P>0.05). Thirty-five (32.7%) of the 107 patients were male and 72 (67.3%) were female, a distribution that did not differ between those with and without old fracture(s) (P>0.05). Of the 51 patients who had an old fracture thirty four patients had at least one old thoracic compression fracture while 29 patients had at least one old compression fracture in the lumbar spine. Twenty two patients had the old fracture(s) in the thoracic spine only, while 17 patients had the old compression fracture(s) only in the lumbar spine. Twelve patients had old fractures both in the thoracic and lumbar spines.

In 23 of the patients having an old fracture this fracture was located at the level just above or below the acute fracture. In 36 of those with an old fracture the acute fracture was located within two levels below or above the level of the old fracture.

Old fracture characteristics

There were a total of 110 old fractures in the 51 patients with an old fracture. Twenty-seven patients had one old fracture, 9 had 2 old fractures, 3 had 3 old fractures, 6 had 4 old fractures, 5 had 5 old fractures, and 1 had 6 old fractures. The location of the old fractures can be seen in Figure 1. Among the patients who had old thoracic compression fracture(s), 21 patients had 1 old fracture, 6 had 2, 5 had 3 and 2 had 4. In those who had old lumbar compression fracture(s), 14 subjects had 1 old fracture, 9 had 2, 3 had 3 and 3 had 4 fractures.



N. Spelling error: Number of vertebrae on the y-axis. Begin Old with a capital letter since you did that with Number of vertebrae!

Figure 1. The distribution of the old fractures included in the study

The influence of the old fracture(s) on the subsequent fracture

The existence or not of an old fracture did not influence the level, grade or type of the acute fracture ($P>0.05$).

Questionnaire results

The outcome measures, pain, disability, back function and quality of life all improved between the three weeks and the three months follow ups both in the patients with and without any old fractures. As can be seen in the figures all the scores and at all the follow ups were worse in the patients with an old fracture than among the patients without such an old fracture (Figures 2,3,4.)

N. Capital letters Pain Int Score. Take out Old fracture Make the same changes in all the figures!

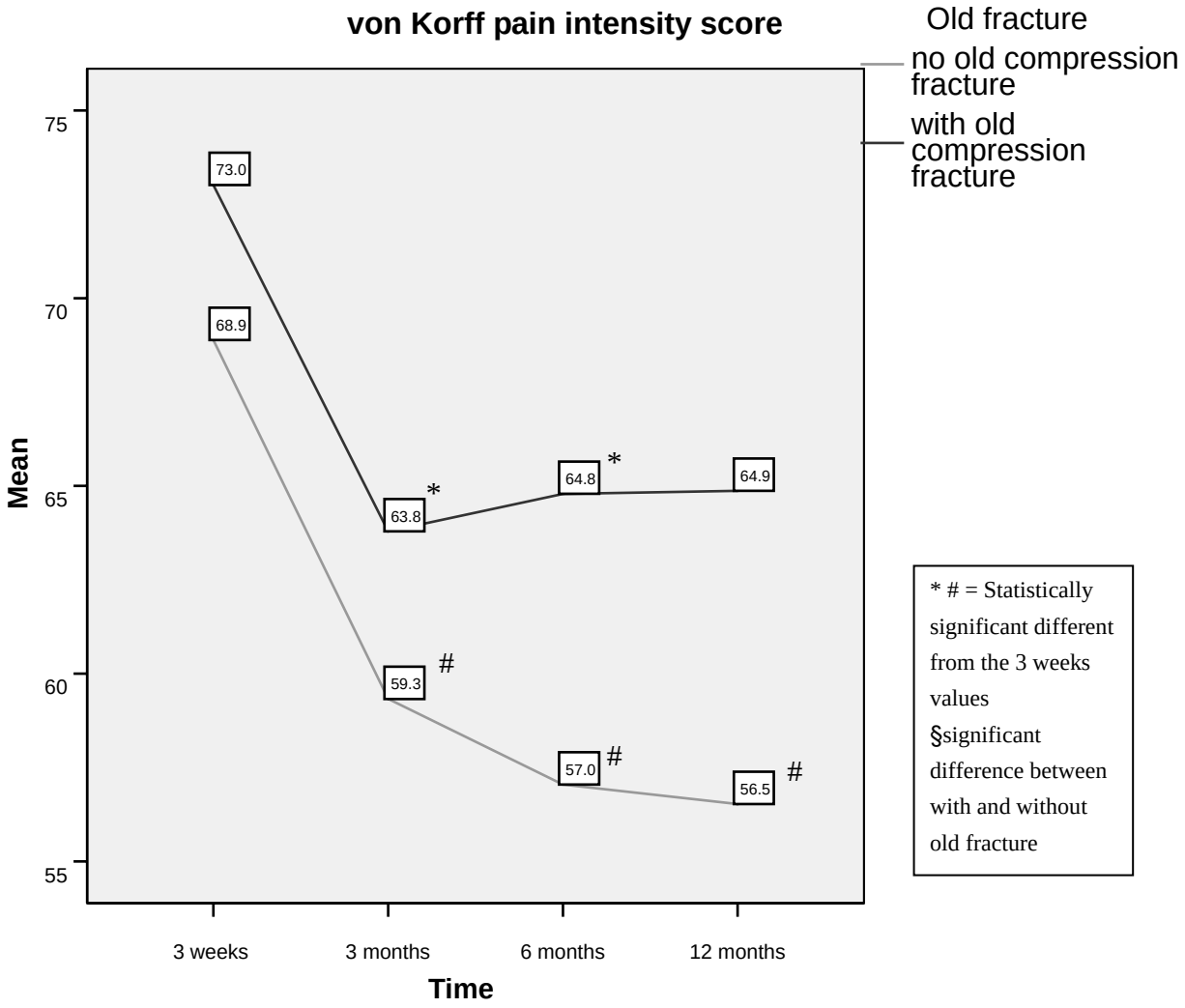


Figure 2. The changes in pain in the group of patients with and without old compression fracture(s) at the four follow up occasions during one year.

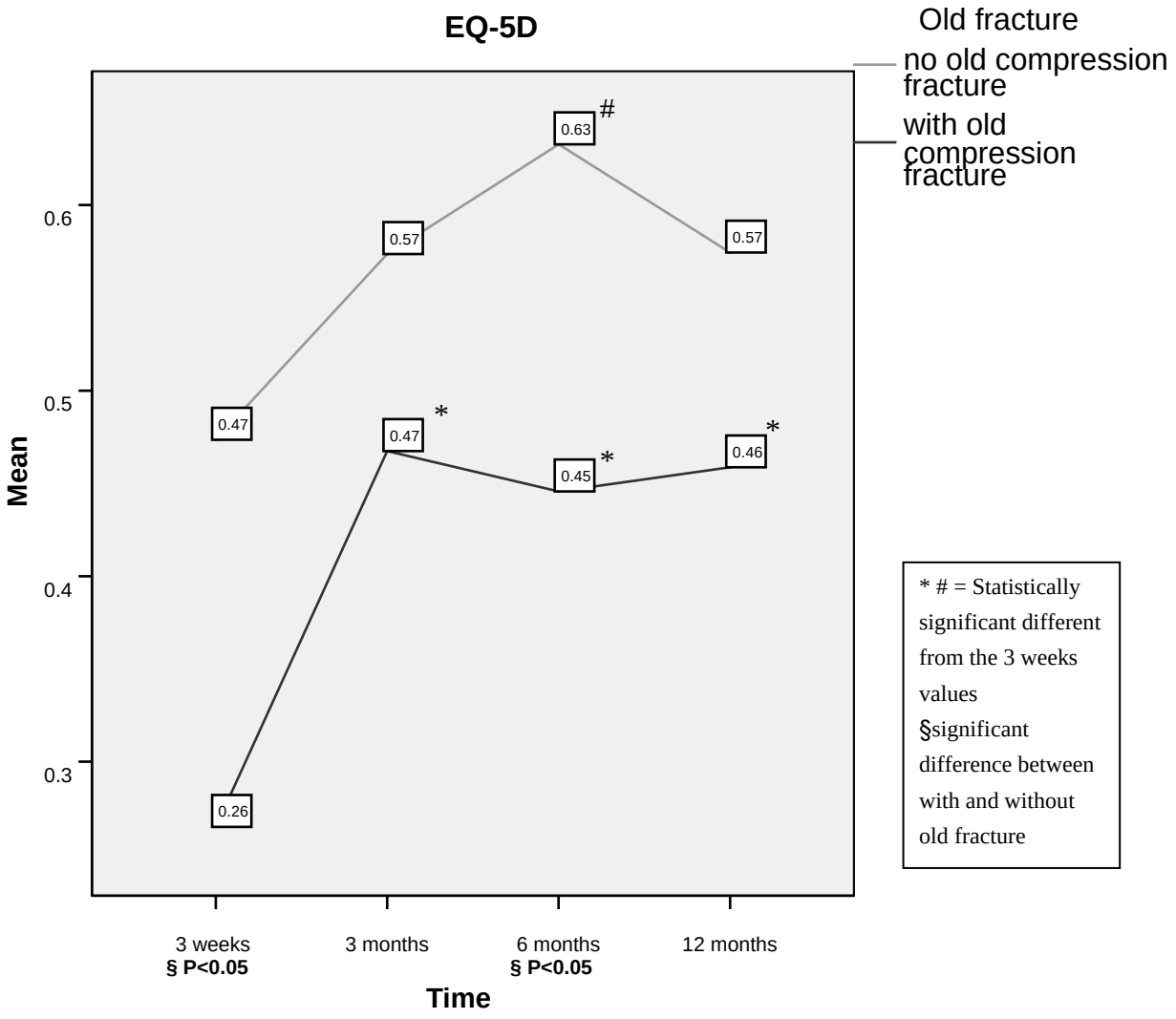


Figure 3. The changes in EQ-5D score among the patients with and without old compression fracture(s) at the four follow up occasions during one year.

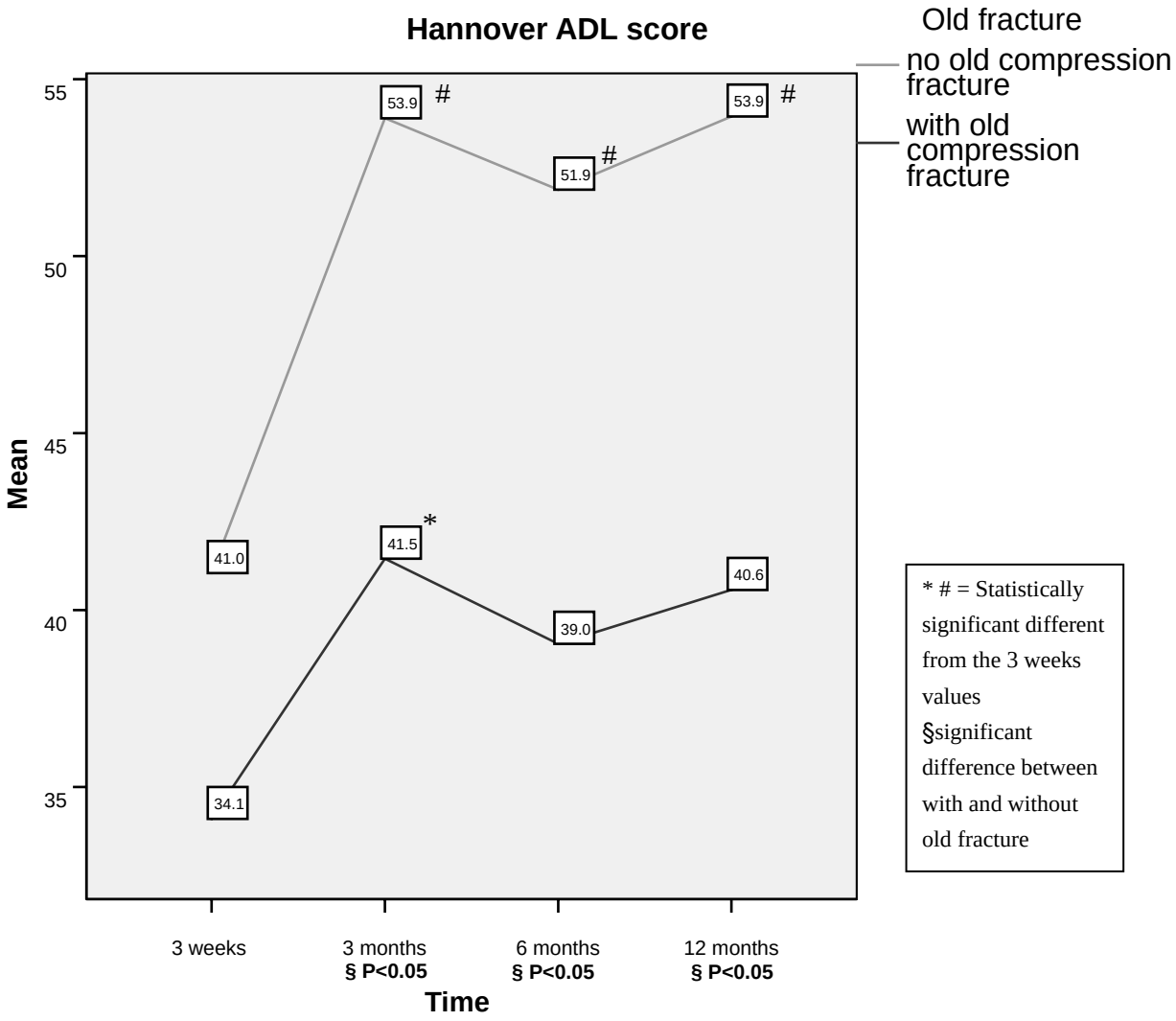


Figure 4. The changes in activities of daily living (Hannover ADL) in the patients with and without old compression fracture(s) at the four follow up occasions during one year.

Table 1. The scores from the four questionnaires in the patients with an acute fracture who had or not had an old fracture.

		No old fracture	*Old fracture*	*Difference*

		(n=56) (n=54)[§]	*(n=51) (n=47)*[§]	*between no and old fracture*
		Mean	*Mean*	*P*
Von Korff's Pain Score	3 weeks	68.9	73.0	Ns
	3 months	59.3*	63.8*	Ns
	6 months	57.0*	64.8*	Ns
	12 months	56.5*	64.9	Ns
Von Korff's Disability Score	3 weeks	64.5	74.0	<0.05
	3 months	53.5*	59.7*	Ns
	6 months	45.0*	58.0*	< 0.05
	12 months	48.4*	60.3*	< 0.05
EQ-5D	3 weeks	0.47	0.26	< 0.05
	3 months	0.57	0.47*	Ns
	6 months	0.63*	0.45*	< 0.05
	12 months	0.57	0.46*	Ns
Hannover ADL Score	3 weeks	41.0	34.1	Ns
	3 months	53.9*	41.5*	< 0.05
	6 months	51.9*	39.0	< 0.05
	12 months	53.9*	40.6	< 0.05

§ the number of patients in the von Korff Disability Score analysis
* comparison with the 3 weeks result, significant difference P<0.05
ns = not significant

Adjacent fracture

Among the patients who had an old fracture, the acute fracture occurred as an adjacent fracture within one vertebra from the old fracture in 23 patients and as a non adjacent fracture in 28 patients. No statistically significant differences were found between the scores of the two groups at any follow up.

The location of the old fracture

The patients who had the old fracture in the thoracic spine were 34 and in the lumbar spine 29. As can be seen in Table 2 the presence of an old fracture in the thoracic spine made all the outcome scores worse than among the patients who had no old fracture. In the lumbar spine on the other hand the presence of an old fracture had almost no extra negative effect on the outcome scores. Table 3.

Table 2. The outcome scores at the four follow ups in the patients who had or not had an old thoracic fracture.

		No old thoracic fracture (n=73) (n=71)§	*Old thoracic fracture (n=34) (n=30)§*	
		Mean	*Mean*	*P*
Von Korff's Pain Score	3 weeks	68.2	76.5	< 0.05
	3 months	58.7	67.4	< 0.05
	6 months	58.4	65.8	ns
	12 months	57.3	67.5	< 0.05
Von Korff's Disability Score	3 weeks	63.4	82.0	< 0.05
	3 months	54.0	61.9	ns
	6 months	46.8	61.0	< 0.05
	12 months	48.5	66.8	< 0.05
EQ-5D	3 weeks	0.47	0.17	< 0.05
	3 months	0.56	0.45	ns
	6 months	0.62	0.39	< 0.05
	12 months	0.57	0.40	< 0.05
Hannover ADL Score	3 weeks	42.4	27.7	< 0.05
	3 months	53.1	36.9	< 0.05

	6 months	50.8	34.9	< 0.05
	12 months	52.1	37.8	< 0.05

§ the number of patients for the von Korff disability score analysis
ns = not significant

Table 3. The outcome scores at the four follow ups in the patients who had or not had an old lumbar fracture.

		No old lumbar fracture (n=78) (n=74) [§]	*Old lumbar fracture (n=29) (n=27)*[§]	
		Mean	*Mean*	*P*
Von Korff's pain score	3 weeks	70.7	71.3	ns
	3 months	61.6	61.2	ns
	6 months	59.3	64.7	ns
	12 months	59.8	62.5	ns
Von Korff's disability score	3 weeks	69.3	68.0	ns
	3 months	55.7	58.2	ns
	6 months	49.0	56.7	ns
	12 months	53.2	55.9	ns
EQ-5D	3 weeks	0.38	0.36	ns
	3 months	0.54	0.48	ns
	6 months	0.56	0.50	ns
	12 months	0.51	0.55	ns
Hannover ADL score	3 weeks	37.6	38.1	ns
	3 months	49.2	44.7	ns
	6 months	46.6	43.5	ns
	12 months	48.9	44.0	ns

§ the number of patients for the von Korff Disability Score analysis
ns = not significant

The number of old fractures and the outcome measures

No correlations were found at any time between the von Korff's Pain Score and the number of old fractures. Except the EQ-5D and Hannover ADL scores at 12 months all the other scores were correlated to the number of old fractures; more old fractures meant worse outcome. In the thoracic spine the number of old fractures were correlated in a statistically significant way to all the outcome scores ($P<0.05$) except the pain score and disability score at 3 moths and EQ-5D and Hannover ADL scores at 12 months. In the lumbar spine no statistically significant correlations were found ($P>0.05$).

The old fractures influence on the kyphosis and the lordosis

The size of the kyphosis and lordosis did not differ between the patients with or without old fractures. Table 4. When the patients with both old fractures in the thoracic spine were compared with patients without such fractures no difference was found between the size of the kyphosis ($P>0.05$), and there was no correlation between the number of old thoracic fractures and the kyphosis angle ($P>0.05$). Table 5.

Spines with both old and acute fractures in the lumbar spine had a smaller lordosis than spines with neither old nor acute lumbar fractures ($P<0.05$). There was also a correlation between the number of lumbar fractures and a decrease of the lumbar lordosis ($P<0.05$).

Table 4. The size of the kyphosis and the lordosis in the patients who had and not had old fractures.

	Without old fracture	With old fracture	P	Total
Kyphosis angle	42.7 (n=21)	44.2 (n=26)	Ns	43.6 (n=47)
Lordosis angle	31.7 (n=50)	29.2 (n=44)	Ns	30.5 (n=94)

Table 5. The angle of the thoracic kyphosis in patients with or without old fractures

	Without thoracic old fracture (n=26)	With thoracic old fracture (n=21)	P
Kyphosis angle	43.8	43.3	ns

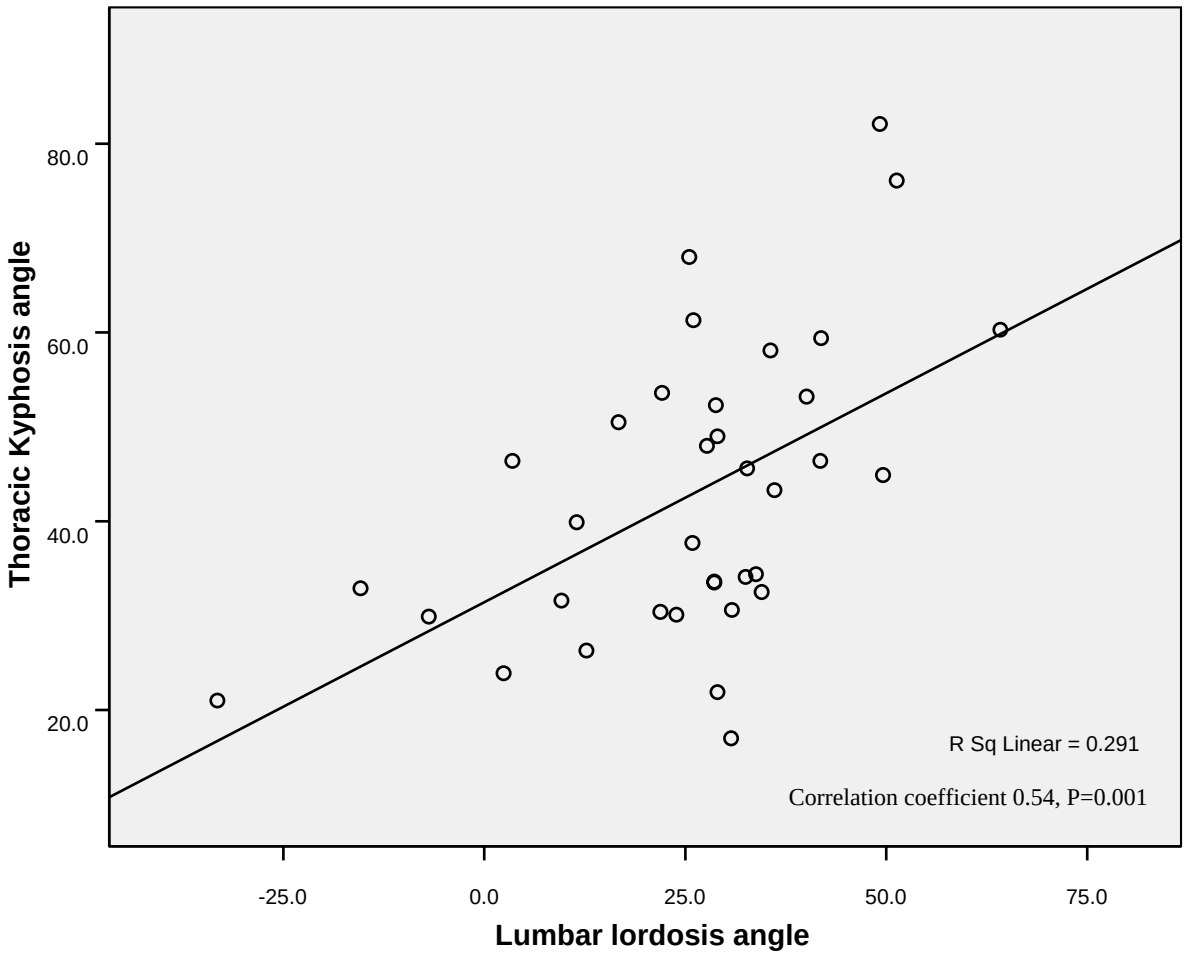
Table 6. The lumbar lordosis angle in patients with or without old lumbar fractures

	Without lumbar old fracture (n=66)	With lumbar old fracture (n=28)	P
Lordosis angle	32.9	25.0	0.03

The relations between kyphosis and lordosis angles

A correlation was found between the size of the kyphosis and the lordosis in the study population (Correlation coefficient 0.54, P=0.001) but no correlations were noted between the kyphosis or lordosis and any of the outcome measures.

Figure 6. The correlation between the angles of the lumbar lordosis and the kyphosis in the 107 subjects



N. Thoracic kyphosis not Kyphosis

DISCUSSION

This study showed that the presence of one or more old vertebral compression fractures especially in the thoracic spine added to the negative effect on pain, disability, QoL and ADL of a subsequent acute fracture. It was also shown that this negative effect of old fractures increased with the number of old fractures and was particularly significant for old fractures in the thoracic spine. The location of the old fracture in relation to the acute one, adjacent fracture analysis, had no influence on the outcomes however.

Old fracture influence on the incident fracture

Several studies have reported a positive association between prevalent vertebral compression fractures and back pain {Ettinger, 1992 #13}{Finsen, 1988 #82}{Ryan, 1992 #70}{Ryan, 1994 #96}{Ross, 1991 #48}{Ross, 1994 #15}{Lyles, 1993 #137} and QoL respectively {Oleksik, 2000 #28}{Hall, 1999 #98}{Salaffi, 2007 #197}{Silverman, 2001 #112}. The influence of a prevalent fracture on the symptoms of an incident fracture has not been clarified in detail before. Cockerill showed that subjects who suffered an incident fracture during a mean follow up period of 3.8 years and already had a prevalent fracture had a lower QoL compared to their matched controls, both with and without a prevalent fracture. It was also shown that there was no significant difference in QoL among the patients with an incident fracture and without a prevalent fracture and either control group, suggesting that it was the second fracture that deteriorated the quality of life {Cockerill, 2004 #166}.

In this study we found that an old vertebral compression fracture made the negative effect of an acute fracture stronger not only when recorded as QoL but also as pain, disability and ADL throughout the follow up year. Earlier it has been reported that the influence of an incident fracture on QoL and disability will last at least for 5 years {Hall, 1999 #98}{Greendale, 1995 #85}{Jinbayashi, 2002 #109}, while the influence on pain remained somewhat shorter, 2-4 years {Begerow, 1999 #36}{Huang, 1996 #80} possibly confirming our finding that pain was less influenced than disability and QoL.

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The number of old fractures and symptoms

The old fractures negative influence on the symptoms after an incident fracture increased according to their number. Several earlier studies have already shown that the number of old fractures, especially moderately and severely deformed old fractures impaired QoL {Oleksik, 2000 #28}{Randell, 1998 #177}, as well as pain and disability {Huang, 1996 #80}{Ross,

1997 #17}{Ettinger, 1992 #13}. The negative relation between the old fracture(s) and the symptoms of the acute one has not been shown earlier however.

Old fracture's location and the incident fracture

Direct relations between old thoracic vertebral compression fractures and the occurrence of back pain and deterioration of the QoL have not been reported earlier {Cockerill, 2000 #12} {Ryan, 1994 #96}. Such relations have so far only been reported for old fractures in the lumbar spine{Oleksik, 2000 #28}{Silverman, 2001 #112}. For the acute compression fracture the findings in the current study were quite different showing that it was in the thoracic spine not in the lumbar that old compression fractures deteriorated both the course and the severity of pain, QoL, disability and ADL.

Adjacent fracture influence

It has been reported earlier that adjacent old fractures i.e. fractures located just above or below the acute fracture added negatively to disability{Silverman, 2001 #112}, pain{Cockerill, 2000 #12}, and QoL {Oleksik, 2000 #28}. The present study could not detect any such negative effects.

The negative effect of the old fracture and the number of old fracture

The reason for the old fracture's negative influence on the subsequent incident fracture is not clear. Several possible explanations have been suggested. It is not unlikely that during the subsequent year new compression fracture(s), even subclinical fractures occur, something that the findings of Rao and co-workers indicated. They reported that 19.2% of the women with a confirmed incidental fracture had a second fracture within one year {Rao, 2003 #21}. It has also been shown that the relative risk of an incident vertebral fracture increases depending on the level of the old fracture level (greatest at T5-T7 and L1-L3) and severity of the fracture{Lunt, 2003 #196}. Another explanation might be a fear for falling and obtaining a new fracture since it has been found that the fear of falling or depression is adversely

affected by pre-existing vertebral fracture {Gold, 1996 #33}. An increased kyphosis may also explain the negative effect of old fracture(s), especially their number since an increased kyphosis is associated with the number of old fracture {De Smet, 1988 #16}, pain and disability {Finsen, 1988 #82; Leidig, 1990 #53}{Ryan, 1994 #96}{Ensrud, 1997 #161} {Ryan, 1997 #194}.

In the present study we could not find a clear association between the kyphosis and the number of old thoracic compression fractures. Reasons for that could be the limited numbers of the subgroups or that the size of the kyphosis has multifactorial reasons for example; postural slumping, age-related changes in the muscles and ligaments, and or intervertebral disk degeneration {Ettinger, 1994 #72}.

Our finding that old lumbar fractures decreased the lordosis significantly (Table 5) coincided with the Pettersen's report {Pettersen, 2007 #133}. Miyakoshi found a negative relation between the lordosis and QoL suggesting that a decrease of the lordosis also decreased QoL {Miyakoshi, 2003 #143}. The findings in the current study could not confirm such negative relations between the lumbar lordosis and QoL or pain, disability and ADL.

The significant positive correlation ($r=0.534$, $P>0.05$) found in this study between kyphosis and lordosis angles (Fig.6) and in patients having both thoracic and lumbar fractures suggested some kind of postural compensating mechanisms e.g. that an increased kyphosis due to a fracture will be compensated for by an increased lordosis.

The reason of the location of the old fracture influence

The difference between the effects of old thoracic and old lumbar fractures is unclear. Different healing times of the fracture injury due to the location within the spine could be one explanation. An indication of the latter could be the findings in the current study that a slight but continuous progress of all the symptoms was recorded among the lumbar fractures while a corresponding continuous deterioration occurred among the thoracic fractures (2008

Suzuki). It is possible that the deterioration of the thoracic vertebral fractures may continue for several years and magnify the impact of subsequent fractures.

Limitations

Some of the patients in the present study had x-ray examinations of their spines that did not include the entire thoracic or lumbar spines. For that reason some old fractures e.g. in the proximal thoracic spine could have been missed and in such away skew the old fracture analyses.

As pointed out earlier there is a possibility that the initial questionnaire scores could be lower among the patients already having an old fracture and in such away explain some of the differences between those with and without old fractures{Oleksik, 2000 #28}.

Conclusion

The deterioration of QoL, disability and ADL after an acute vertebral fracture was worsened in patients who already had an old vertebral compression fracture. The deterioration was aggravated according to the number of old fractures.

Thoracic old fracture(s) had more and significant impact on the course of the incident fracture than old lumbar fracture(s).

The great difference in prognosis between the first fracture and subsequent ones seemed to emphasize the importance not only of primary fracture prevention efforts but secondary as well.