THE ROLE OF X-RAY EXAMINATION IN THE DIAGNOSIS OF OSTEOARTHROSIS AND IN THE DETERMINATION OF THE CLIMBERS' BIOTYPE

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X JORNADES DE MEDICINA I AUXILI A LA MONTANAYA

Barcelona, October 31 - November 3, 1991

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Abstract
Modern extreme rock climbing has become a top performance sport in which enormous strains are exerted on the climbers fingers. Since 1987 225 Czechoslovak sport climbers were followed up and repeated examination showed a fast increase in finger joint deformities. Because of frequent long-lasting pain and injuries X-ray examination of climbers fingers was performed in 44 men 22.9ń5.2 years old climbing difficulty grade (UIAA) 8- to 10- (mean 9- ń2) in 1990.
Osteoarthrotic (OA) nodes, fusiform swelling and flexion deformities were found in 77%, long-lasting pain in fingers in 50%, and both in 39%. 89% of climbers showed either finger deformities or suffered from long-lasting pain. X-rays showed OA changes in 43.2% and osteoperiosteal irritation (OI) in 29.5% of climbers. Pathologic X-ray examination was found in 26 climbers (59%) and significant correlations between climbers age and OI ($r=0.533$, $p<0.001$), OA signs in X-ray and OA nodes and long-lasting pain in fingers ($r=0.353$ and $r=0.362$ ($p<0.05$) respectively) were stated.
At this opportunity X-ray examination enabled anthropometric measurement of climbers fingers for determination their biotype and forces which are exposed by their sport activity to.

INTRODUCTION

In 1989, first complex results of the study concerning finger overuse injuries performed in Czechoslovak sport climbers by the Medical Commission of the Czech Mountaineering Association were presented and following question propounded: "what kind of relation is there between the sport climber's biotype and the occurrence of overuse syndromes in the upper extremities?" It seemed necessary to work out a suitable biotype method, to ensure the characteristics of sport climbers can be biotyped, to evolve a standardised method for the examination of climbers and the classification of their finger damage and to attempt to correlate sport climbers' biotypes with the occurrence of hand overuse syndromes.
According to above mentioned conclusions determination of the climbers' biotype and its correlation with the occurrence of hand overuse syndromes was designed. In 1989 the only finding casting light in that direction seemed to be a significant correlation between the body height of sport climbers and number of nodes on their small finger joints [8].
There is a generally known observation that most of elite world sport climbers are rather of smaller body height as well as less body weight. It can give one an idea of greater forces which small finger joints of tall climbers with their long fingers are exposed to, in comparison with climbers of less body height in which the lever of force during the climbing on small holds is shorter.
In the course of last year the conditions for research have not been very much favourable in Czechoslovakia and the working group of the Medical Commission has not been succeeded to accomplish all planned measurements and investigations

METHODS

Until May 1990 225 climbers have been interrogated using the modified Bertschi and Radlinger's anamnestic questionary [1] and subjected to physical orthopaedic examination in the field [10], e.g. at sport climbing competitions in Czechoslovakia.
Climbers' age, duration of their sport activity, the maximum difficulty grade of the UIAA scale reached, body height and body weight, localization of long-lasting pain in extremities and spine were taken down. Deformities of small finger joints - nodes, fusiform swellings and flexion deformities - were searched for. Because of frequent long-lasting pain in fingers and on request respectively, X-ray examination of the hand and wrist was recommended to 72 climbers in their domicile in autumn 1990. Thickening of soft tissues of the fingers, osteoperiosteal irritation in phalanges posttraumatic findings as well as osteoarthrotic signs were evaluated.
At this opportunity x-ray examination enabled to measure the distance from capitulum ossis metacarpalis to the distal margin of tuberositas unguicularis of the distal phalanx in the IInd, IIIrd and IVth finger and the length of these fingers respectively.
For more detailed analysis only 34 of 44 climbers with x-ray examination were selected. The lapse of time between the clinical and x-ray examination did not exceed one year in these climbers. The data and regression relations between all variables were processed by means of a statistical program, Statgraphics 2.1.

RESULTS

A group of 34 male climbers was characterized as follows: mean age 23 years, mean body height 177 cm, mean body weight 69 kg, duration of climbing activity 7 years on an average, and mean maximum climbing difficulty grade 9- grades UIAA. The IIIrd finger was the longest - 95 mm on an average, mean length of the IInd and IVth finger amounted to 84 and 91 mm respectively (Table I).
One climber complained of long-lasting pain in his arm, 4 in the wrist, 6 in the fore-arm, 9 in the shoulder, 11 in the elbow, and 19 e.g. 56% in their fingers. The IIIrd and the IVth finger were the most frequently affected, symmetrically in the right and left hand (Table II). Concerning the lower extremity, 5 climbers suffered from pain in knees, and 4 in the spine.

Table I. Characteristics of sport climbers.

		average	s.d.	range
Age	[years]	22.6	5.0	16 - 37
Height	[cm]	176.9	6.6	163 - 187
Weight	[kg]	68.3	8.1	51 - 84
Broca-index		88.8	7.0	73.3 - 102.8
BMI	{*}	21.8	1.8	18.2 - 25.4
Performance	{**}	8+	2	8- - 10
Activity	[years]	7.0	2.9	3 - 15
Length: IInd finger	[mm]	83.5	4.2	74 - 90
Length: IIIth finger	[mm]	94.5	4.5	84 - 102
Length: IVth finger	[mm]	91.0	4.5	80 - 98

{*} Body Mass Index {**} grade UIAA

Table II. Painful fingers in sport climbers.

	RIGHT HAND					LEFT HAND				
Finger	I	II	III	IV	V	I	II	III	IV	V
Number	0	2	10	9	1	0	2	10	7	3
%	0	5.9	29.4	26.5	2.9	0	5.9	29.4	20.6	8.8

Nodes in small finger joints were present in 8 climbers, fusiform swellings in 23, and flexion deformities in 20 climbers. Altogether one of these deformities at least was found in 28 e.g. 82% of climbers.

Table III. Finger deformities in climbers' fingers.

RIGHT HAND

FINGER	I		II			III			IV			V		
JOINT	mcp	ip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip
nodes	0	1	0	5	2	0	4	2	0	3	1	0	3	1
fusif.sw.	0	0	0	3	0	0	20	0	0	13	1	0	2	1
flex.def.	0	0	0	1	1	0	2	0	0	2	1	0	10	4
Total	0	1	0	9	3	0	26	2	0	18	3	0	15	6

LEFT HAND

FINGER	I		II			III			IV			V		
JOINT	mcp	ip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip
nodes	0	0	0	4	2	0	2	0	0	2	0	0	1	0
fusif.sw.	0	0	0	5	0	0	20	0	0	12	0	0	2	0
flex.def.	0	0	0	1	1	0	3	0	0	4	1	0	8	2
Total	0	0	0	10	3	0	25	0	0	18	1	0	11	2

fusif.sw.: Fusiform swelling flex.def.: Flexion deformities
mcp: metacarophalangel ip: interphalangeal pip: proximal interphalangeal
dip: distal interphalangeal

Nodes were the most frequently found in the IInd, IIIrd, and IVth finger. The right hand was twice more frequently affected than the left hand (Table III). Proximal interphalangeal joints were damaged in 72%, distal ones in 27%.

Fusiform swellings occurred symmetrically on both hands: for the main part in the IIIrd and IVth finger in the proximal interphalangeal joints.

The most frequent occurrence of flexion deformities was found in the Vth finger, in the proximal interphalangeal joints.
Altogether the most finger deformities were present in the IIIrd, IVth and in the Vth finger.

Table IV. X-ray changes in climbers' fingers.

RIGHT HAND

FINGER	I		II			III			IV			V		
JOINT	mcp	ip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip
soft.tis.	0	0	0	17	1	0	24	1	0	22	0	0	0	0
peri.iri.	1	0	7	1	0	8	2	0	8	2	0	5	1	0
osteoart.	11	11	12	12	14	12	14	14	12	11	14	11	11	12

LEFT HAND

FINGER	I		II			III			IV			V		
JOINT	mcp	ip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip	mcp	pip	dip
soft.tis.	0	0	0	19	1	0	24	1	0	22	0	0	0	0
peri.iri.	0	0	6	1	0	7	2	0	7	2	0	4	1	0
osteoart.	11	11	12	12	14	12	14	14	12	11	14	11	11	12

soft.tis.: changes (thickening) of soft tissues, peri.iri.: osteoperiosteal irritation, osteoart.: osteoarthrosis
mcp: metacarophalangel ip: interphalangeal pip: proximal interphalangeal dip: distal interphalangeal joint

In x-ray examination (Table IV) thickening of soft tissues of the fingers were recorded in 79%, osteoperiosteal irritation in the phalanges in 24%, and osteoarthrotic signs in 47%, symmetrically in the IInd, IIIrd and IVth finger. Abnormal x-ray findings were found in 85% of 34 climbers. Altogether either soft tissue changes or signs of osteoarthrosis or finger deformities or long-lasting pain were present in 32 of 34 climbers (94%).
Using linear regression analysis significant correlations were found between age and fusiform swellings and flexion deformities in climbers' fingers, as well as duration of climbing activity and osteoperiosteal irritation in x-ray examination. With increasing age greater body mass indexes were found. Higher body weight was associated with high incidence of nodes in finger joints as well as flexion deformities and greater number of painful fingers. Linear correlation was also found between the body height and incidence of osteoarthrotic damage in finger joints as well as nodes and flexion deformities.
The length of fingers which depends, of course, on body height, showed the highest dependence of nodes, flexion deformities, number of painful fingers, signs of osteoarthrosis, and changes in soft tissues in fingers (Table V, VI).
X-ray examination in climbers' fingers confirmed the relation between pain in fingers and findings of osteoarthrosis, and thickening of soft tissues in fingers and nodes and fusiform swellings respectively (Table VI, VII).

Table V. Regression analysis I:
Finger deformities and X-ray changes vs. anthropometrics.

	nodes	fusiform swelling	flexion deform.	all deformities	thickening soft tissue	periosteal irritation	osteo-arthrosis
Age	.240	.324+	.319+	.410*	.172	.515*	.111
Activity	.292+	.080	.036	.213+	.192	.383*	.075
Height	.360*	.000	.288+	.280+	.128	.147	.351*
Fi.Length	.528*	.233	.286+	.490*	.331*	.065	.428*
Weight	.473*	.018	.498*	.421*	.000	.183	.242
BMI	.346*	.027	.474*	.350*	-.111	.124	.028
Fi.Pain	.253	.000	.254	.213	.195	-.124	.401*

Fi.Length: Length of the IIIrd finger Fi.Pain: Finger pain + p<0.1 * p<0.05 ** p<0.001

Table VI. Regression analysis II: Performance vs. anthropometrics.

	Height	Weight	Broca	BMI	Performance	Finger Pain
Age	-.018	.163	.275+	.261+	.062	.139
Activity	.000	.099	.152	.141	.183	.111
Height	-	.737**	.038	.185	.143	.242
Fi.Length	.492*	.410*	.068	.142	.050	.344*
Weight	.737**	-	-	-	-.220	.290+
BMI	.185	-	-	-	-.185	.197
Fi.Pain	.242	.290+	.166	.197	.198	-

Fi.Length: Length of the IIIrd finger Fi.Pain: Finger pain
+ p<0.1 * p<0.05 ** p<0.001

Table VII. Regression analysis III: Deformities vs. X-ray changes.

	Thickening soft tissue	Periosteal irritation	Osteo-arthrosis	Finger pain
Nodes	.407*	.144	.278+	.253
Fusiform swelling	.588**	.155	-.026	.000
Flexion deformit.	.076	-.023	.150	.254
all deformities	.572**	.157	.182	.213

+ p<0.1 * p<0.05 ** p<0.001

DISCUSSION

The number of participants as well as the performance level in competitive sport climbing continues to grow. Young climbers are starting to climb and compete at increasingly earlier age. Finger training has also reached a state in which it can easily do more harm than good. All climbers, young, older, and elite, are finding the need to train harder and longer in an effort to excel.

The development of chronic overuse damage in extreme rock climbing is a very fast process, and the percentage of overuse injuries is increasing. Within two or three years, repeated examination of 50 climbers showed an increase in the number of finger joint deformities from 3.4 to 6.9. Joint deformities were present in 37 climbers at the first examination, and in 45 e.g. 90% at the second. The maximum UIAA grade reached increased from 8+ to 9, but the incidence of nodes and fusiform swellings, and a little less flexion deformities were also significantly higher [9].

This last study in Czechoslovak sport climbers confirmed expected relations between anthropometric parameters and health complaints as well as pathological changes. In contrast to our study in 1989 [8], relations between age and painful fingers, and relationship between maximum climbing performance and duration of climbing activity, painful fingers, and fusiform swellings were not proved. This difference can be explained by the fact, that maximum climbing performance increased from 8- to 9- grades UIAA, and finger deformities were found in 63% in 1989, and in 82% in 1990.

Usual X-ray examination has comparatively little sensitivity in the diagnosis of finger overuse injuries in sport climbers. X-ray signs of osteoarthrosis can be difficult evaluated in early stages, particularly in our young climbers.

Mrs. Leal and her co-workers [4] reported cortical hypertrophic osteosclerosis, hyperostosis in flexor surface of phalanges, and microfractures, cortical hyperostosis and destruction of subchondral bone in metacarpophalangeal and interphalangeal joints in 11 free-climbers. Bollen and Bowker [2] described changes appearing in climbers' finger joints at around thirty

years of age, with small osteophytes and soft tissue swelling around the proximal interphalangeal joints and cortical thickening of the phalanges.
At the present times sophisticated imaging procedures such as high-resolution radiography and computed tomography, technecium bone scanning techniques, and magnetic resonance imaging could be used. The latter is emerging as an excellent method of noninvasively imaging injuries to soft-tissue such as tendons, ligaments and cartilage [3].
Tendons and joint capsules are affected with the strain of climbing performance earlier and more often than bones, however great forces due to the configuration of the fingers on small holds can surely damage the joint cartilage.
Up to now, it was not possible to characterize climbers' biotype and its relation to finger overuse injuries more exactly, but there is accordance with observation of Lysens and his co-workers [5-7]. They have established an overuse-prone profile of young athletes and found that overuse injuries are frequently associated with high body weight and large body height.
Zaźko a Z horec [11] reported that successful climbers are of average body height, comparatively lower body weight, and longer upper extremities but shorter fingers.
Significant linear correlation between the length of the fingers and their damage in sport climbers confirmed the fact that climbers with long fingers are affected more often than climbers of smaller body height because of greater forces which the former are exposed to.

CONCLUSION

The observations done show that

- the prevalence of finger overuse injuries and finger deformities in sport climbers is still increasing during their climbing activity.
- Relation between climbers' body height, body weight as well as finger length and osteoarthrosis is evident.
- X-ray examination can well demonstrate the sequalae of great forces which are climbers' fingers exposed to.

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