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RESEARCH

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Hight return-to-sport rate following traumatic spine injury in amateur athletes

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Abstract

Introduction Data on the resumption of sporting activity (return-to-sport, RTS) after traumatic spine injuries are mainly available for elite athletes. This study aimed to determine the RTS rate in amateurs after spine injury and to identify factors possibly influencing RTS.

Methods First, a retrospective analysis of clinical data of patients with traumatic spine injuries receiving inpatient treatment at a national trauma center from 2016 to 2020 was performed. Patients up to the age of 60 who were active in sports before the injury were included. Patients with the following relevant concomitant injuries were excluded: spinal cord injury, pelvic injury, extremity injuries, as well as craniocerebral trauma grade 2 or higher. A telephone interview on participants' RTS within the first year after the injury was conducted. Participants with early and those with late or no RTS were compared in univariate analysis regarding potential influencing factors. The level of significance was set to $p<.05$.

Results Thirty-seven women (39%) and 57 men (61%) were included. The mean age was 44 years (16–60). The numbers of patients per injured segment of the spine were: cervical 15 (16%), thoracic 28 (30%), lumbar 33 (35%), multiple spine segments 18 (19%). Thirty patients (32%) were treated conservatively and 64 (68%) surgically. The RTS rate after six months was 62%, corresponding to 57 patients. Compared to patients with late or no RTS, patients with RTS within six months had a significantly lower BMI (24.6 vs. 27.4 kg/qm, $p=.004$), had isolated cervical spine injuries significantly more often (24% vs. 6%, $p=.020$), and had undergone outpatient or inpatient rehabilitation significantly less often (35% vs. 72%, $p<.001$). There were non-significant trends regarding mean age (42 vs. 46 years, $p=.175$), surgical therapy (66% vs. 75%, $p=.333$), and the proportion of patients who, before the injury, had been physically active for at least five hours per week (50% vs. 33%, $p=.113$). Patients with RTS within six months had sustained their spinal injury in a sports accident twice as often (28% vs. 14%, $p=.121$). Gender, preexisting medical or spinal conditions, severe injuries (types A4, B or C according to AO Spine), and surgical therapy were not significantly associated with RTS. The RTS rate within twelve months was 81% (76 patients).

Conclusion The RTS rate in amateur athletes after an isolated spinal injury without spinal cord injury was high, with 62% after six and 81% after twelve months. This reflects the effectiveness of the existing treatment and posttreatment concepts. Normal-weight patients and isolated cervical injury are favorable factors for RTS. The use of inpatient rehabilitation as a marker of protracted healing is associated with delayed or no RTS.

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Introduction

Traumatic spinal injuries, although rare [1, 2], can have severe physical and psychological consequences for the individual patient [3, 4]. Because spinal trauma often affects younger patients, and postoperative mobility limitations can negatively impact quality of life [5], the resumption of physical activity after traumatic spinal injuries is a relevant issue.

Due to the physiological role of the spine as a central structure of the trunk and as a protective structure for the spinal cord, its functionality is particularly important for physical activity: sufficient mobility, stability and resilience of the neck and back are important in many sports. Pain in the neck and back can hinder or make sport impossible. Additionally, psychological aspects after injury and possibly surgery to the spine could hinder patients from participating in sports if the fear of renewed injury is pronounced during physical activities.

Existing literature addressing rates and timing of return-to-sport (RTS) following traumatic spine injuries is often focused on professional athletes [6] with a particular preponderance of male American football players with cervical spine injuries [7, 8]. There are also studies on RTS after elective surgery for non-traumatic spinal diseases [9–11]. One available study on outcomes after spine injury also investigating RTS in amateurs included patients with concomitant injuries to the spinal cord, the brain, the extremities, or the pelvis [12].

Thus, the literature has not yet satisfactorily answered which proportion of patients with isolated spine injury can resume sporting activity, and at what level of performance. A prognostic statement on RTS can be a major concern for patients and treating medical professionals. Therefore, the primary objective of this study was to analyze the rate of RTS after traumatic spine injury in amateur sport. The secondary objective was to identify risk factors that may lead to delayed or missing RTS.

Methods

This single-center retrospective study was conducted at a national trauma center in Germany. It was approved by the ethics committee in charge (Ethics Committee of the State Medical Association Rhineland-Palatinate, Mainz, Germany; application number 2022–16283).

Participant selection and recruitment

All patients treated at the study site for traumatic spine injuries (discoligamentous injuries or vertebral fractures) from 2016 to 2020 were identified in the hospital database and screened for documented inclusion and exclusion criteria (Table 1, category A). Patients were not included if they were over 60 years old, had a pathological spine fracture, had sustained their injury in attempted suicide, or presented with relevant concomitant injuries like pelvic or extremity fractures. A list of potentially eligible patients was created and patients on the list were contacted in reversed chronological order, starting with those treated most recently. Via telephone interview, which had been developed specifically for this study (supplementary material) further inclusion and exclusion criteria were queried (Table 1, category B). If eligible, participants were informed about the nature and aims of the study orally and with a patient information form. They had the chance to ask further questions before finally signing an informed consent form.

Treatment and posttreatment recommendations

Patients were treated conservatively or surgically based on established recommendations of care [13–15]. Early postoperative functional therapy was begun during the hospital stay for all patients. Outpatient continuation of physical therapy after discharged was recommended. Posttreatment recommendations advised against carrying weights greater ten kilogram for six weeks and refraining from manipulations of the spine. After six weeks, full weight bearing was allowed. Activities with high axial loads or abrupt changes of direction were advised against for six months postoperatively.

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
A. Criteria documented in the hospital	
• Inpatient treatment at study site between 2016–2020	• Pathological fracture (including osteoporotic fracture)
• Age at injury ≤60 years	• Injury caused by attempted suicide
• Time of trauma clearly defined	• Relevant concomitant injuries
• Vertebral fracture or discoligamentous injury	– Spinal cord injury – Structural brain injury – Injuries of extremities necessitating conservative treatment > 2 weeks or surgery – Pelvic fracture
B. Criteria determined via telephone interview	
• Active in sports before injury	• Insufficient language comprehension
• Informed consent	

Data collection

We retrospectively collected data on demographic variables, concomitant injuries and spine injury classification according to AO Spine [16–18]. If the appropriate classification was not documented, classification was performed on postinjury CT scans according to the above cited classification systems. Data on conservative or surgical therapy was also extracted, along with data on any revision or implant removal surgery. We also collected data on preexisting medical conditions and pathologies of the spine, which were complemented with information participants gave during the telephone interview. Based on this information we calculated the Charlson Comorbidity Index (CCI) for each participant [19].

Telephone interview

All participants underwent a structured telephone interview with predefined questions and possible answers, created for this study (supplementary material). The first part of the interview collected information on posttreatment, physical therapy, and rehabilitation after hospital discharge as well as any revision surgery or implant removal not performed at the study site; physical therapy in this context meant a series of out-patient appointments of short duration, regularly two to three times per week, focusing on patient instruction and education and enabling patients to continue the exercises on their own, while rehabilitation describes continuous treatment over the duration of multiple weeks with multiple hours of exercise and education per day. We also asked for any comorbidities that were not documented in our hospital database. The second part of the interview dealt with sports activity before the injury (kinds of sport, duration and frequency per week), duration until RTS after the injury, and duration and frequency of sports twelve months after the injury. We also asked whether participants had subjectively reached their preinjury level of performance in sports. RTS was defined as partaking in any sports activity, irrespective of level of performance or of the individual participants' primary sport before the injury.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics Ver. 27. Continuous variables were reported with means and standard deviations, ordinal variables with medians and inter-quartile-ranges. In accordance with the possible answers in the telephone interview we calculated RTS rates after injury within two weeks, four weeks, two months, four months, six months, nine months, and twelve months as percentages of the total study population. Individual RTS rates for relevant subgroups were reported accordingly.

Participants were divided into a group with early RTS, defined by the authors as RTS within six months after injury, and a group with late or no RTS, defined as RTS more than six months after the injury or no RTS by the time of the interview. In a case-control analysis, these two groups underwent univariate comparison of factors potentially influencing timing of RTS. Here, we used the chi-squared test for categorial variables, a two-sided t-test for continuous variables, and the Mann-Whitney-U-test test for ordinal variables. P-Values <0.05 were considered statistically significant. We did not adjust for multiple testing in this exploratory study.

Results

Demographics

A total of 94 participants, 37 women (39%) and 57 men (61%), were recruited for the study (Table 2). Mean age at the time of the injury was 43.8 years (SD 14.1, range 16–60). Mean BMI was 25.7 kg/m^2 (SD 4.7, range 17.9–46.9), while median CCI was 0 (IQR 0, range 0–4). Preexisting spine pathologies were present in 40 participants (43%), most frequent being chronic neck or back pain (27%). Mean time between the injury and the interview was 38 months (range 17–67 months).

Sports before injury

Most frequent primary sports before the injury were fitness (20 participants), cycling (15 participants) and Nordic Walking (14 participants, Fig. 1).

Spine injury and therapy

The distribution of injuries and therapies over the different regions of the spine were as follows: Only cervical spine: 16 (17%), four with conservative, twelve with surgical therapy; only thoracic spine: 28 (30%), 13 conservative, 15 surgical therapy; only lumbar spine: 36 (38%), nine conservative, 27 surgical therapy. Multiple areas of the spine were affected in 14 participants (15%), three of these participants were treated conservatively and eleven surgically. More severe injury types B, C or A4 according to AO Spine were present in 41 participants (44%, Fig. 2).

In total, conservative therapy was performed in 29 participants (31%), surgical therapy in 65 participants (69%). All 65 surgically treated patients received internal fracture fixation, comprising isolated posterior internal fixation in 40 patients, isolated anterior internal fixation in seven patients, and combined anterior and posterior internal fixation in 18 patients.

Three participants (5% of surgical patients) had to undergo revision surgery because of wound healing disorders after dorsal instrumentation, one participant in the thoracic and two in the lumbar spine. Apart from these, no surgical adverse events occurred.

Table 2 Demographics, preexisting medical and spinal conditions

Sex		
Women	37	39%
Men	57	61%
Age at injury (mean, SD, range)	43.8 years	(SD 14.1, 16–60)
Comorbidities		
Charlson Comorbidity Index (median, IQR, range)	0	(IQR 0, 0–4)
Body Mass Index (mean, SD, range)	25.7	(SD 4.7, 17.9–46.9)
Preexisting spine pathology (n, %)	40	43%
Chronic neck/back pain	26	27%
Scoliosis	13	14%
Disc protrusion	12	13%
Arthritis	7	7%
Osteoporosis	6	6%
Spinal stenosis	4	4%
Spondylolisthesis	2	2%
Ankylosing spondylitis	1	1%
Other	8	9%

SD, standard deviation; IQR, interquartile range

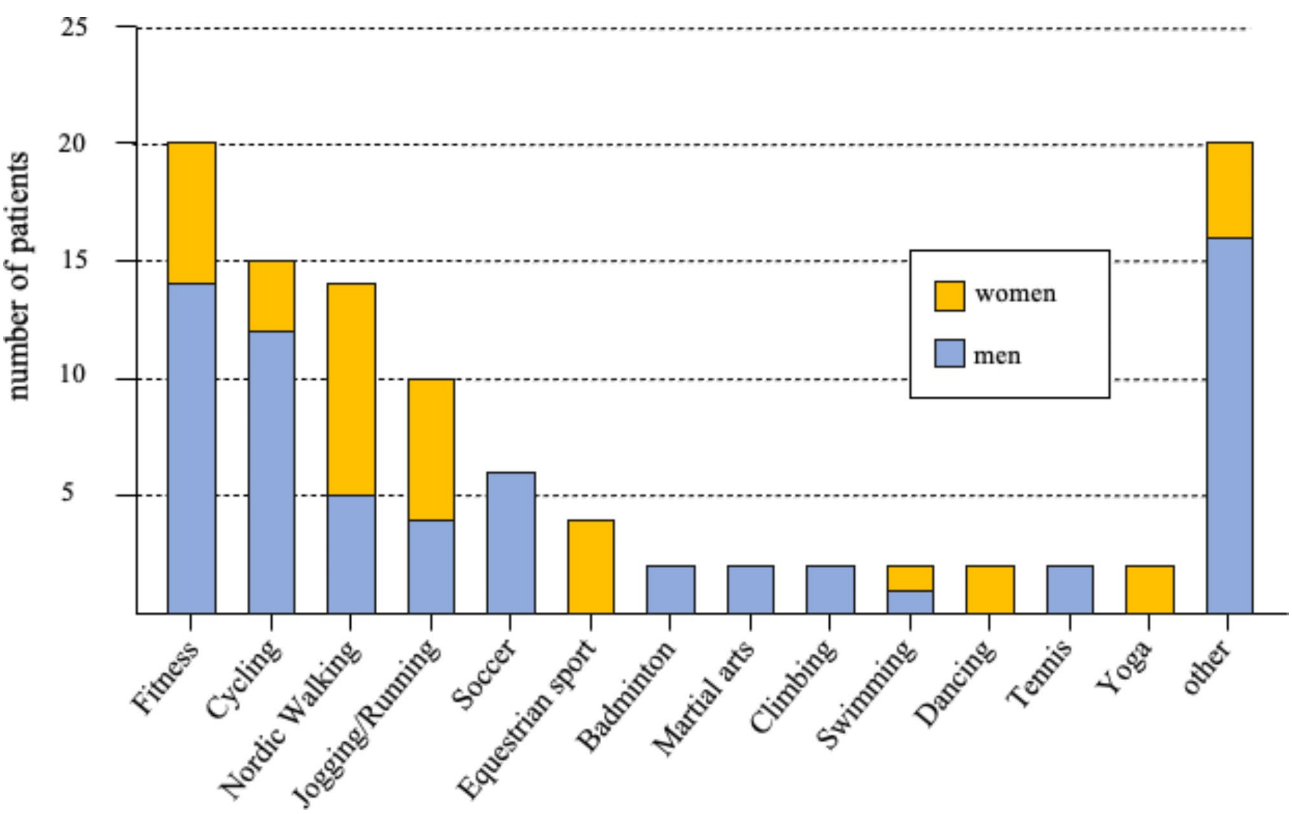

Fig. 1 Schematic representation of participants' primary sports before the spine injury

Twenty-three participants had undergone implant removal of dorsal instrumentation until the telephone interview (35% of surgical patients), two of them at a hospital other than the study site. These were the only two cases of surgery at a different hospital in the study population.

Posttreatment

Fifty-seven participants (80%) reported having received physical therapy after discharge from the hospital. The larger part, 44 participants (59% of participants having received physical therapy), finished physical therapy within four months after the injury. Fourteen participants

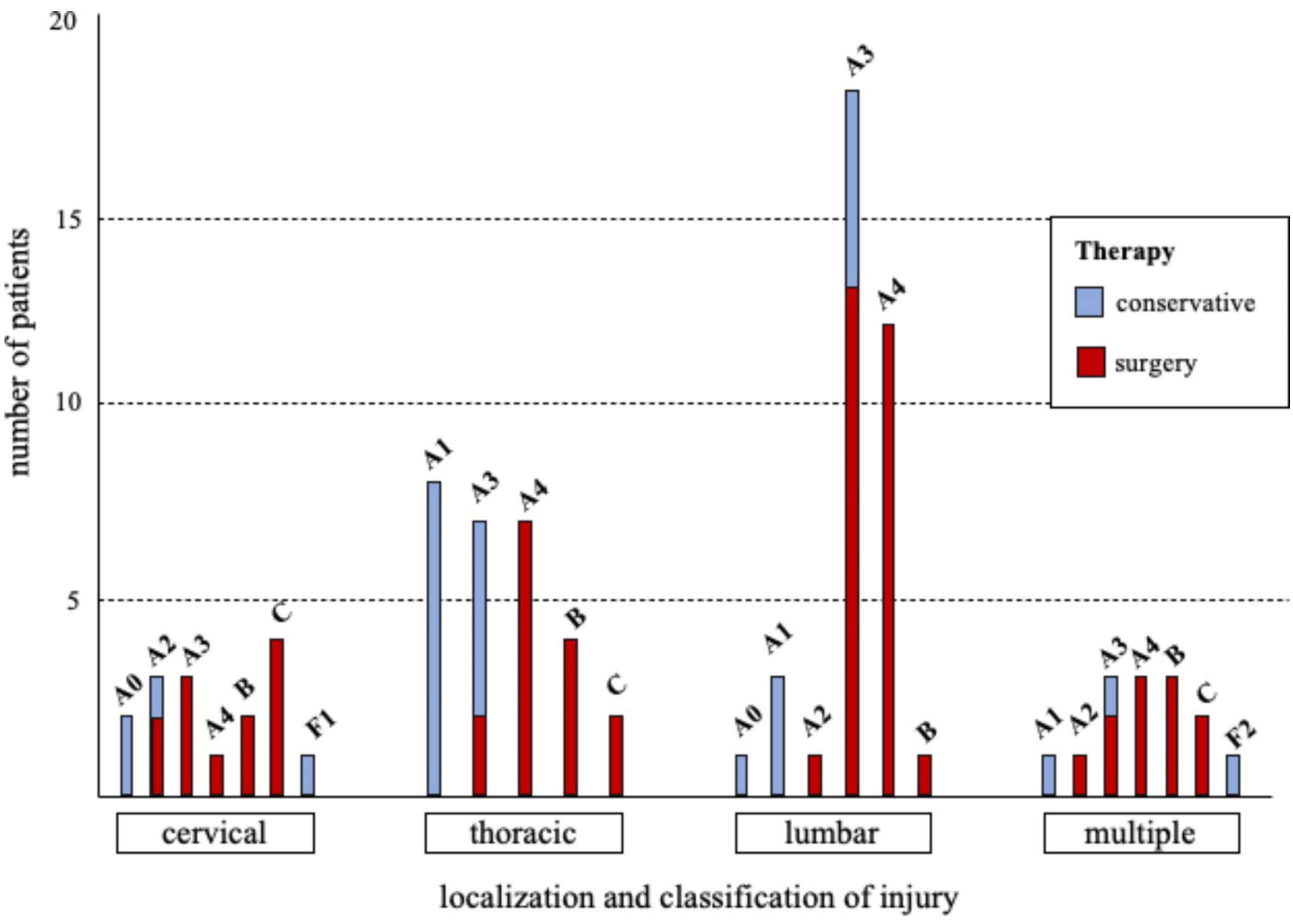

Fig. 2 Presentation of the type and level of injury according to the AO Spine classification as well as conservative or surgical therapy

(19%) reported still receiving physical therapy at the time of the interview.

In- or outpatient rehabilitation was received by 46 participants (49%), 28 participants for up to four weeks (61% of participants with rehabilitation) and 18 participants (39%) for more than four weeks.

RTS rate over time

Fifty-eight participants (62%) reported RTS within six and 76 participants (81%) within twelve months after the injury (Fig. 3). At the time of the telephone interview, 82 participants (87%) had returned to sports. RTS rates were highest for injuries to the cervical spine, were all patients returned to sport within twelve months, followed by thoracic and lumbar spine injuries with the worst outcome in cases of multiple injured regions. Patients who could be treated conservatively fared better than surgical patients (Table 3).

Risk factors for late or no RTS

Univariate analysis of factors potentially influencing RTS in participants with early RTS (as defined by the authors as RTS within six months) and late or no RTS was performed (Table 4). Here, participants were divided into a group with early RTS within six months and a group with late or missing RTS. These two groups were then compared concerning various patient-, injury-, and treatment-related factors potentially influencing RTS in univariate analysis. Statistically significant differences were present concerning BMI, solitary cervical spine injury, and rehabilitation. Mean BMI in participants with late or no RTS was 2.8 kg/m^2 higher than in participants with early RTS (95% confidence interval: 0.9–4.7, $p=.004$, Fig. 4). Participants with early RTS had isolated cervical spine injuries significantly more often (24 vs. 59%, $p=.020$). In the group of participants with delayed or no RTS, the proportion of participants who took advantage of rehabilitation programs was twice as high as in the group of participants with early RTS (72 vs. 35%, $p<.001$, Fig. 5).

Non-significant yet notable trends were present in some variables (Table 4). Interestingly, participants who had sustained their spine injury in a sport accident were more prevalent in the group with early RTS (27 vs. 14%, $p=.121$). Participants who partook in sports longer and more frequently per week before the injury were also

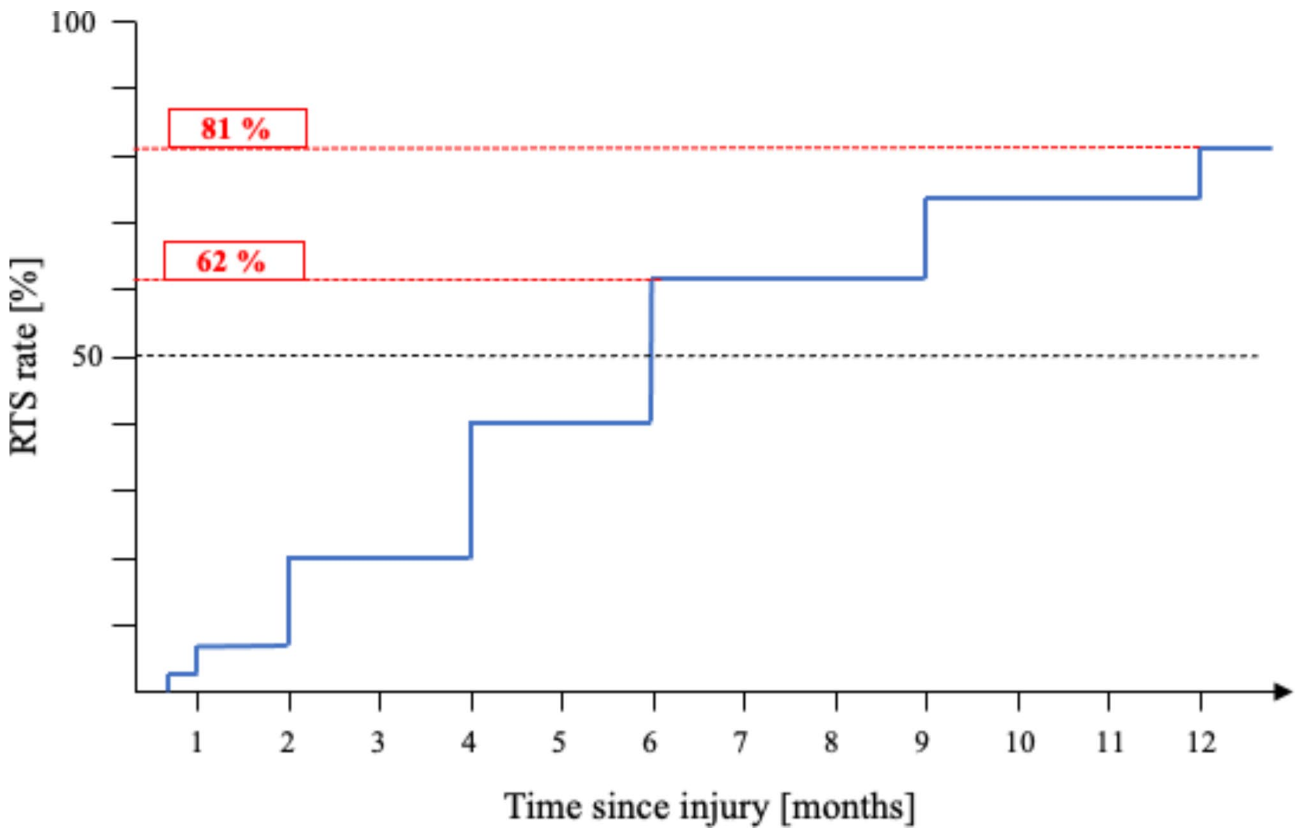

Fig. 3 Return-to-sport rate of the whole cohort over one year after the injury, highlighted are the rates after six and twelve months

Table 3 Return-to-sport rates within six and twelve months and rate of patients having reached their subjective preinjury level of performance after one year depending on injured region of the spine and conservative or surgical therapy, %, (n)

Injured region and therapy			RTS within…					
			six months		twelve months		Reached preinjury level of performance after twelve months	
Cervical	**100**	**(16)**	**88**	**(14)**	**100**	**(16)**	**63**	**(10)**
Conservative	100	(4)	100	(4)	100	(4)	100	(4)
Surgical	100	(12)	83	(10)	100	(12)	50	(6)
Thoracic	**100**	**(28)**	**54**	**(15)**	**79**	**(22)**	**36**	**(10)**
Conservative	100	(14)	64	(9)	79	(11)	43	(6)
Surgical	100	(14)	43	(6)	79	(11)	29	(4)
Lumbar	**100**	**(36)**	**58**	**(21)**	**78**	**(28)**	**25**	**(9)**
Conservative	100	(9)	67	(6)	78	(7)	33	(3)
Surgical	100	(27)	56	(15)	78	(21)	22	(6)
Multiple	**100**	**(14)**	**57**	**(8)**	**71**	**(10)**	**7**	**(1)**
Conservative	100	(3)	67	(2)	100	(3)	0	(0)
Surgical	100	(11)	55	(6)	64	(7)	9	(1)

RTS, return to sport

more frequent in the group with early RTS, suggesting that preinjury motivation plays are role in postinjury RTS.

The factors age, injury to multiple regions of the spine, more severe injury morphology (types A4, B or C according to AO Spine) or surgical therapy were negligibly and statistically non-significantly pronounced in the group with late or no RTS.

Changes in activity and subjective performance

Thirty-five participants (37%) spent the same amount of time and eight participants (9%) had increased the time they spent on sports one years after the injury, while 33

Table 4 Univariate comparison of factors potentially influencing return to sports in participants with early (within six months) and delayed or missing RTS

	RTS within six months (*n* = 58)	**No RTS within six months (*n* = 36)**	***p*-value**
Patient characteristics			
Age [mean (SD)]	42.2 (14.2)	46.3 (13.8)	.175[1]
Sex (female)	38%	44%	.427[2]
Charlson Comorbidity Index [median (IQR)]	0 (0)	0 (0)	.401[3]
Preexisting spine pathology	43%	41%	.891[2]
BMI [mean (SD)]	24.6 (3.5)	27.4 (5.7)	**.004[1]**
Injury and therapy			
Only cervical spine affected	24%	6%	**.020[2]**
Multiple regions of the spine affected	14%	17%	.704[2]
Surgical therapy	66%	75%	.333[2]
Injury type B, C or A4 (AO Spine)	41%	47%	.579[2]
Sport injury	28%	14%	.121[2]
Post treatment			
Physical therapy	78%	83%	.500[2]
Rehabilitation	35%	72%	**< .001[2]**
Motivation			
At least 5 h sport/week before injury	50%	33%	.113[2]
At least 3 x sport/week before injury	60%	47%	.213[2]

RTS, return to sport; SD, standard deviation; IQR, interquartile range

Statistical test used: [1]t-test, [2]Chi-squared test, [3]Mann Whitney U test

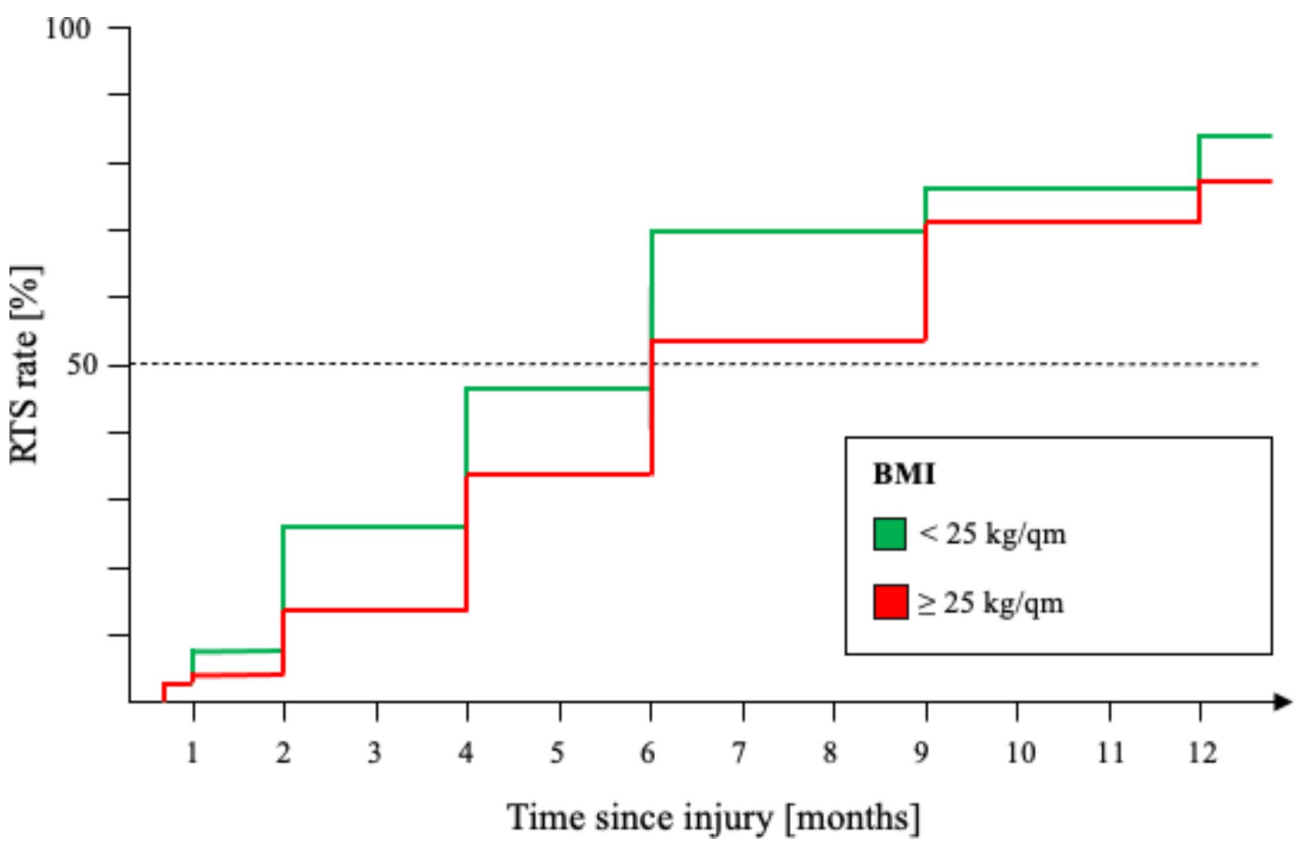

Fig. 4 Return-to-sport rates of participants with different BMI over one year after the injury

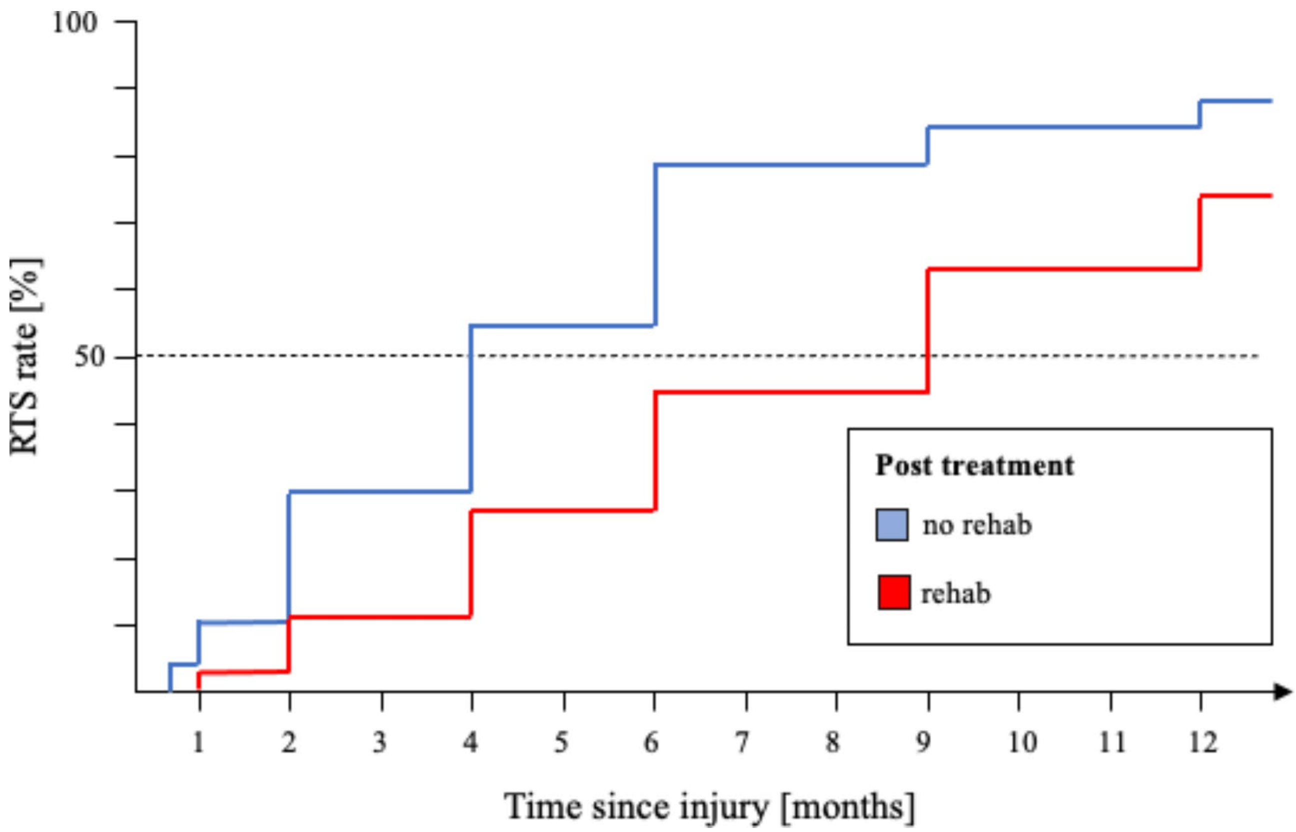

Fig. 5 Return-to-sport rates of participants with rehabilitation (rehab) and without rehabilitation over one year after the injury

Table 5 Time spent on sport before the injury and changes one year after the injury

	Before injury Total, *n* (%)	Changes one year after the injury					Total population one year after the injury, *n* (%)
Time spent on sport per week, h		**> 4**	**> 2–4**	**> 1–2**	**0.5-1**	**no RTS**	
> 4	41 (44)	17	7	7	5	5	24 (26)
> 2–4	32 (34)	4	12	7	3	6	20 (21)
> 1–2	17 (18)	2	0	6	4	5	20 (21)
0.5-1	4 (4)	1	1	0	0	2	12 (13)
no sport	0	-	-	-	-	-	18 (19)

participants (35%) spent less time on sports, and 18 participants (19%) had not returned to sport after one year (Table 5).

Asked, weather they had subjectively reached their preinjury level of performance in sports one year after the injury, 30 participants answered "yes" (32%), 46 answered "no" (49%), while 18 participants (19%) had not returned to sports (Table 3). Again, subjective preinjury level of performance was most frequently reached in participants with isolated cervical spine injuries and after conservative therapy.

Discussion

In the present cohort-study with follow-up, the RTS rate after isolated traumatic spine injury in amateurs was systematically investigated for the first time. A total of 94 patients were included based on clinical data and a telephone interview. After six months, 62% of participants had returned to sport, and 81% after one year. Unfavorable factors for early RTS were an increased BMI and the necessity of inpatient rehabilitation, while an isolated injury of the cervical spine was a positive prognostic factor.

RTS rates after spine injury

To the best of our knowledge, there are no dedicated analyzes of RTS after traumatic spine injury in amateur sports in the current literature. The studies found primarily provide information on RTS in elite athletes [7, 11, 20, 21]. Also, degenerative diseases are predominantly described here (e.g. spinal canal stenosis, disc herniations [11]). Other studies include patients with concomitant injuries to the spinal cord, extremities, pelvis or brain, hampering conclusions on the effect of isolated spine injuries on RTS [12]. It should not be ignored that elite athletes have a different motivation for the RTS than amateur athletes, as they derive their main income from sport, whereas sport is not a financial priority for amateurs. And although there is a considerable body of literature on RTS in professional athletes, even for this cohort no clear consensus for the correct time for RTS exists among experts [6].

In a prospective multicenter study by Knop et al. from 2001, 372 patients with fractures of the thoracic and lumbar spine were followed up [12]. Two-hundred and eighteen patients were active in sports before the injury. At the time of the follow-up examination, only 142 patients were active in sport, corresponding to an RTS rate 65% after the follow-up of four to 61 months. A precise analysis of the numbers and correlations between rehabilitation and RTS was not performed, also, patients with relevant concomitant injuries and spinal cord injury were included, resulting in a more heterogenous cohort than in our study and potentially causing the markedly lower RTS rate compared to our findings.

Sedrak et al. examined RTS after lumbar disc herniation in over 1000 elite athletes in a systematic review in 2021 [11]. No significant difference was found between the surgical and the conservative group concerning RTS, with RTS rates of over 80% in both groups. In a literature review by Leider et al. 349 top athletes were analyzed [7] who underwent various cervical spine surgeries, mainly for disc herniation, but also including patients with radiculopathy or spinal cord contusion. Fractures or discoligamentous injuries were not described. The authors deducted that RTS after surgical treatment was safe in asymptomatic patients and was less frequent in symptomatic or conservatively treated patients. A meta-analysis of overall RTS rates was not done, but RTS rates and postinjury performance were described as generally favorable, thus being consistent with our results. Ruffilli et al. analyzed RTS after dorsal spinal fusion in 112 athletically active adolescents with idiopathic scoliosis with an RTS rate of 68% [22].

Although RTS rates in our cohort were high, it must be pointed out that only one third of participants invested the same time into sport one year after the injury, and only one third reported having subjectively reached their preinjury level of performance one year after the injury. The effect of traumatic spine injury on physical performance and wellbeing must therefore not be underestimated and further research into sport-related patient-reported outcome is necessary to understand problems arising in RTS in spine trauma patients.

Factors influencing RTS

Since spine injuries are heterogenous, affect patients of various ages, with different preexisting conditions, and necessitate a wide range of different surgical and conservative treatment methods, we wanted to explore factors potentially influencing RTS rates.

Interestingly, age, medical comorbidities measured by CCI, and preexisting spinal conditions did not play a significant role. This points to a high motivation for sports participation and RTS after injury even in the patient cohort of higher age [23]. We must point out, however, that patients older than 60 years at the time of the injury were not included in this study to reduce heterogeneity concerning preexisting conditions and fracture morphology. Thus, RTS after spine injury in elderly patients is an interesting direction for further research.

In the present study, patients in the early RTS group had a significantly lower BMI (24.6 kg/m^2 vs. 27.4 kg/m^2, p=.004) than those in the late and missing RTS group. Although a small difference, it should be noted that mean BMI of participants with early RTS (24.6 kg/m^2) is considered as "healthy weight", whereas the mean BMI of participants with delayed or missing RTS (27.4 kg/m^2) falls within the "obesity range". There are few comparable findings in the literature. In the study of Ruffilli et al. on adolescents with surgery for idiopathic scoliosis, there were no significant differences in BMI between patients with and without RTS [22]. In a study by Than et al. [24], return to work in 127 patients with herniated discs three months after surgery was not significantly different in dependence of BMI. In addition, it is important to note that in athletes, an elevated BMI does not strictly correlate with obesity, as increased muscle mass increases BMI [25]. In the face of the low absolute difference in BMI in our study, the role of BMI and RTS warrants further research.

We found a significant association between rehabilitation and late or missing RTS in our cohort. This must, however, not be interpreted as evidence against the benefits of rehabilitation, as the latter was probably mainly taken advantage of by participants with a prolonged course of healing, which was also associated with delayed or missing RTS. Early functional movement-oriented therapy with physiotherapy, sports therapy and occupational therapy are measures recommended in a German S2k guideline on rehabilitation after traumatic injury of the thoracic and lumbar spine [26] and better functional results in patients undergoing rehabilitation after thoracic and lumbar spine fractures have been demonstrated in the literature [12]. The meaning of rehabilitation and physical therapy in the posttreatment of spine injuries is reflected in the high prevalence of these treatment modalities in our cohort, although randomized trials are missing.

While not statistically significant, it was interesting so see a trend of higher rates of early RTS in participants with higher frequency of sport per week and higher total duration of time invested in sport before the injury, suggesting that motivation and fitness before the injury might play a role. Accordingly, Knop et al. [12] identified a lack of training at the time of the trauma as an unfavorable predictor for functional outcome after thoracic and lumbar spine fractures. Contrary to intuition, participants with sport-related injury of the spine were twice as frequent in the group with early RTS. Fear of renewed injury seems not to have held these participants back from returning to physical activity. These findings warrant a more detailed look into psychological traits related to preinjury activity and to coping with traumatic injury in further research, which might influence patients' RTS.

There was a marked and statistically significant association of isolated cervical spine injury and early RTS in our cohort, with 88% of participants with isolated cervical spine injury achieving RTS within six months and 100% within one year. This is interesting and warrants further research into patient-reported outcomes of this cohort. In contrast, the literature on professional athletes advocates careful RTS after cervical spine injury and surgery, often stating that athletes should be pain-free, at full strength and range-of-motion, before RTS [6, 27]. Brauge et al. reported the case of a young professional rugby player sustaining severe neurological injury due to a hyperflexion trauma during a match after he had returned to sport following a two-level cervical fusion [20]. Fortunately, no such events occurred in our cohort.

Limitations

The present study is limited by its retrospective, single-center design. Especially the follow-up data collected via telephone interview are prone to recall bias. Participants may have inaccurately remembered their recovery timelines or preinjury activity levels, negatively affecting the reliability of our findings. The study group consisted of patients with heterogeneous injuries, a variety of treatment modalities, and different types of sport. Subgroup analyses for different sports and different treatment modalities was not performed because of small subgroup sizes. Posttreatment was not strictly monitored and variations in individual patients' posttreatment like physical therapy and rehabilitation might have influenced RTS rates. In this exploratory study no statistical adjustment for multiple testing was made.

Extrapolation of our findings on a wide population of patients with spine injuries must be performed cautiously, as the study site is a national trauma center and only individuals treated as inpatients were considered as potential participants. Our cohort might thus include more severe injury cases than an average spine injury population so that RTS rates in the latter might be higher than reported in our study. Also, since we excluded patients with spinal cord injury, no statement on functional outcome such as RTS in this important patient population can be made.

RTS was defined liberally and was assumed, if participants stated that they were active in any sports activity after their injury, disregarding level of competition, intensity, or whether they managed to return to their original primary sport. Other studies have applied stricter definitions of RTS [28]. In this regard, the differentiation of early and late RTS, was arbitrarily chosen by us and is not defined in the literature.

This study's main strength is its dedicated investigation of RTS after spine trauma in amateurs, excluding patients with relevant concomitant injuries, thus giving a clearer picture on spine trauma's effect on sports participation than was previously available.

Future research indications

Based on this study's findings and limitations we believe the following research indications to be of interest. In a prospective study, the limitations associated with recall bias could be circumvented. More reliable and quantifiable outcomes, such as physical tests and standardized outcome measures could improve the understanding of RTS and RTS rates after spine injuries in amateur athletes. Monitored and uniform posttreatment across all participants could help to further discern the isolated impact of different spine injuries. A lager sample size would allow the analysis of clinically relevant subgroups based on injured region, injury morphology, and surgical treatment modality. The influence of different primary sports before and after the injury could also be investigated in appropriate subgroup sizes.

Finally, both psychological factors, like resilience in the face of injury and fear of reinjury, as well as socioeconomic aspects like access to high-quality rehabilitation services should be investigated, as they might have an additional influence on RTS.

Conclusions

The RTS rate in amateur athletes after an isolated traumatic spine injury is high, with 62% after six and 81% after twelve months. This reflects the effectiveness of the existing treatment and posttreatment concepts. Normal weight and isolated cervical injury are favorable factors for RTS. The use of rehabilitation as a marker of protracted healing is associated with delayed or no RTS. Substantial limitations in participants' subjective level of performance and time spent on sports one year after the injury warrant further research into sport-related patient-reported outcome.

Abbreviations

BMI	Body mass index
CCI	Charlson Comorbidity Index
IQR	Inter-quartile range
RTS	Return to sport
SD	Standard deviation

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13102-024-01017-x.

Supplementary Material 1

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Author contributions
P.R.: Methodology (equal); data curation (equal); supervision (equal); conceptualization (equal); investigation (equal); writing – original draft (equal), review and editing (equal). T.H.: Methodology (equal); data curation (equal); funding acquisition (equal); supervision (equal); conceptualization (equal); investigation (equal); writing – original draft (equal), review and editing (equal). M.K.: Methodology (equal); data curation (equal), funding acquisition (equal), supervision (equal), conceptualization (equal); investigation (equal); writing – original draft (equal), review and editing (equal). S.Y.V.: review and editing (equal). P.A.G.: Methodology (equal); supervision (equal); conceptualization (equal); investigation (equal); writing – original draft (equal); review and editing (equal). M.K.J.: Methodology (equal); data curation (equal); funding acquisition (equal); supervision (equal), conceptualization (equal); investigation (equal); writing – original draft (equal); review and editing (equal).

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the ethics committee in charge (Ethics Committee of the State Medical Association Rhineland-Palatinate, Mainz, Germany; application number 2022–16283). Every participant provided their informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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