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Fast rehab after midshaft clavicula fractures in elite cyclists and motocross riders

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Clavicle fractures are one of the most common injuries in cyclists and motocross riders. Although a fast return to sport is imperative for athletes, there is only limited literature on short-term functional outcomes after open reduction internal fixation of a clavicle fracture in a homogenous group of athletes. The aim of this study is to evaluate early (first 6 weeks) functional outcomes, return to sports and complications of elite or high-level recreational (± 8000 km per year) cyclists and motocross riders after surgical treatment of a midshaft clavicle fracture. The main study parameters were Quick Disabilities of the Arm, Shoulder and Hand (QuickDash); QuickDash sports module, pain in rest and movement (Numeric Pain Rating Score) and time to return to sports (training indoor/outdoor and competition). All parameters were taken pre-operatively and at 2/4/6/12/24 weeks post-operative. A total of 34 cyclists (6 LTFU) and 9 motocross riders (2 LTFU) were included at baseline. A significant decrease in Quick dash scores between preoperative (33 ± 1.2) and 2 weeks PO (21.5 ± 1.2) and between 2 and 4 weeks PO (16.1 ± 1.3) was found for cyclists. The QuickDash scores of the motocross riders statistically improvement from preoperative (31.6 ± 3.3) to 6 weeks PO (14.1 ± 3.3). NRS score in rest for cyclists decreased significantly from 3.6 ± 0.2 to 1.0 ± 0.2 after two weeks. After 4 weeks, 93% of cyclists and 57% of motocross riders were training outside. After 6 weeks, 56% of cyclists and 57% of motocross riders had returned to competition. Our results show that early surgical treatment of midshaft clavicle fractures in elite cyclists and motocross riders is a safe method with few complications and good functional outcomes.

Keywords: clavicle fracture, cyclists, motocross rider, return to sports, functional outcome, return to competition.

INTRODUCTION

Clavicle fractures are one of the most common injuries around the shoulder and account for 2.6-5% of all fractures in adults[1,2]. They often occur due to falls on the ipsilateral shoulder, the outstretched hand or due to high-energy impacts over the bone[3]. As such, athletes are especially prone to this type of injury. Sports activities account for 30-45% of all clavicle fractures with approximately 16% occurring from cycling[1,3-5].

The treatment of clavicle fractures depends on the location and nature of the fracture. Allman (1967) classified clavicle fractures into three groups based on the location along the bone; middle third, medial third and lateral third[4]. Middle-third fractures are the most common and account for 69-82% of all clavicle fractures[6]. In general, this type of fracture is usually treated conservatively by temporary immobilisation for pain relief using a sling or collar ‘n cuff in combination with analgesics and/or kinesio-tape[3,7]. Although long-term results are the same and operative treatments of clavicle fractures can result in major complications, such as neurovascular injury and infection, several studies have shown that they also improve the functional outcomes and significantly decrease long-term complications, such as non-union and symptomatic malunion[3,8]. Particularly for athletes, where a fast return time to sport is imperative, an operative intervention can be the preferred method. Athletes treated nonoperatively often have a missed training time of 6-12 weeks depending on the healing time, shoulder motion, strength and patient comfort[9]. Operative intervention can lead to an early stabilisation of the fracture and thus athletes have a faster return time to sport.

A systematic review of Robertson & Wood (2016), focussed on the return rate and time to sports following clavicle fractures, showed that the operative treatment had superior results compared to non-operative treatments[10]. However, there was a lack of detailed

descriptions of the studies, which limited the ability to compare the outcomes from different treatment modalities[10]. Data was further confounded by the heterogeneity of the studied cohort. Many studies usually follow up on their patients at fixed time points far in the future, such as 3 months and 6 months post-operative. However, as fast rehab is one of the major benefits of an operative intervention it would be more prudent to follow patients in the first 6 weeks of their rehabilitation.

Few studies have focussed on a homogeneous group of athletes and their functional outcomes scores and return rate to sport in the first 6 weeks post-operative a clavicle fracture (i.e., fast rehab)[11]. It is standard practice in our clinic to perform surgical interventions on midshaft clavicle fractures in high-level and competitive athletes on the day of the trauma or the day afterwards. The purpose of this study is to analyse the early functional outcomes (QuickDash and NRS), the time to return to sports (both training and competition), and complications of both elite and recreational cyclists and motocross riders after a surgical intervention for a midshaft clavicle fracture. We hypothesize that a fast surgical intervention of midshaft clavicle fractures in these athletes combined with a fast rehabilitation protocol is a safe and effective procedure and results in a fast return to sport time for both training and competition.

MATERIALS AND METHODS

This study was conducted as a single center, prospective, observational cohort study from March 2019 to June 2021. The study was approved by both the local ethics committee and the Ethics Committee KU Leuven (B322201940309) and was conducted according to the declaration of Helsinki and Good Clinical Practice. Patients presenting with a surgical indication for midshaft clavicle fracture and meeting the eligibility criteria were recruited from the Department of Orthopedics in AZ Herentals, Belgium. Written informed consent was obtained from every participant before study inclusion.

Inclusion criteria consisted of patients with a midshaft clavicle fracture, aged between 16-65 years, recreational (±8000 km per year) or professional motocross riders or cyclists. Patients were excluded if they had prior surgery within the last three months or other significant trauma to the shoulder.

In total, 6 different orthopaedic surgeons performed urgent (i.e., the day of the trauma or the day afterwards) open reduction and plate fixation of the clavicle fracture. All the procedures were done in beach-chair position, using the anterosuperior approach centred over the fracture. Supraclavicular nerve branches were preserved where possible. All fractures were reduced using standard techniques and the Locking Clavicle Plate (Acumed, Hillsboro,Oregon) was utilised on the superior part of the clavicle. During the procedure we had at least 3 bicortical screws on each side of the fracture. It was the surgeon's choice to add extra screws to secure smaller fragments when needed. Often, additional non resorbable suture tape was used for extra stability of a butterfly fragment. When the ORIF was executed, a standardised layered closure was performed.

All patients were motivated postoperatively to use the arm and shoulder as fast as pain allowed with no restrictions of the range of motion. Patients were given a sling but this was not mandatory to use. Moreover, there were no restrictions on when the athletes could start with indoor or outdoor training. All patients were counselled on the risks of potential wound infection while training with an unhealed wound and fracture. They were advised that if they train indoors during the first 3-4 days, the intensity should be low, in order not to sweat.

Data collection consisted of the numeric pain score (NRS), the abbreviated version of the Disabilities of the Arm, Shoulder and Hand (QuickDASH), the QuickDASH sports module and a patient specific return-to-sport questionnaire that patients received pre-operatively, 2/4/6 weeks and 3/6 months postoperative. Pain was scored on a scale of 0 (no pain) to 10 (worst pain imaginable)[12]. The Quickdash is a questionnaire that measures an individual's ability to complete tasks, absorb forces, and severity of symptoms. In the patient-specific questionnaire the athletes were asked when they started indoor training on rollers, outdoor training and competition[13-15].

Postoperative complications such as infection (joint, local), wound healing complications, non-union, hardware complications, hematoma or ecchymosis, neurological symptoms (loss of sensibility, strength loss, paraesthesia, scar sensitivity, dystrophy, cold intolerance), joint stiffness or frozen shoulder (extension -30°, flexion -120°) and revision surgery were recorded. Plate removal due to plate irritation was not regarded as a complication and was separately registered.

Statistical analysis was done using the R-program (2013. Vienna, Austria: R Foundation for Statistical Computing)[16]. All baseline and outcome data were tested for normality by means of the Shapiro-Wilk

test. Baseline continuous and ordinal variables (age, BMI) were expressed in a mean value and standard deviation. A repeated measures ANOVA was used for repeated measures over time of the clinical scores (NRS, QuickDash, QuickDash sport) for both cyclists and motocross riders. A P-value of less than 0.05 was considered statistically significant.

RESULTS

The total study population consisted of 43 athletes with 34 cyclists (30 male, 4 female) and 9 motocross riders (all male). All demographics can be found in Table I. The average age of the male cyclists was 36 y/o (range 16-61) and 24 y/o (range 16-29) for female cyclists. The average age of the motocross riders was 25 y/o (range 16-36). In total, 23 of the 43 operations were performed on the dominant side. Of all athletes, 23 (53,5%) competed professionally in races and 20 (46,5%) only recreationally.

All fractures were classified as closed Allman type I fractures and there were no neurovascular lesions at the time of surgery. The operation was performed at the day of the trauma or the day after and no intra-operative complications were noted. Follow up was on average 14 months (range, 6-30 months) and there were in total 8 patients lost to follow up, of which 6 cyclists and 2 motocross riders.

Table I. — Patient demographics (age, weight, height, operated arm, dominant arm and sports level) of cyclists (n=34) and motocross riders (n=9)

	Cyclist	Motocross Racers
Total (n)	34	9
Men (n)	30	9
Age	36 [16-61]	25 [range 16-36]
Weight (kg)	70 [47-94]	75 [range 64-85]
Lenght (cm)	179 [166-191]	182 [range 173-190]
Side	15L, 15R	4L, 5R
Women (n)	4	–
Age	24 [16-29]	–
Weight (kg)	58 [51-67]	–
Lenght (cm)	169 [163-176]	–
Side	3L, 1R	
Dominant arm		
Yes	18	5
No	16	4
Pre-injury sports level		
Competitive	15	8
Recreational	19	1

Functional outcome and NRS scores preoperative and postoperative (PO) (2/4/6 weeks, 3/6 months) are summarized in Table II.

Table II. — QuickDash, QuickDash sport and NRS scores (mean ± SD) at pre-operative, 2/4/6 weeks, 3 and 6 months postoperative for both cyclists and motocross riders

		cyclist	Timepoints	p-value	motocross rider	Timepoints	p-value
QuickDash	pre-operative	33 ± 1.2	*pre-op - 2w PO*	p<0,05	31.6 ± 3.3	*pre-op - 2w PO*	p>0,05
	2w PO	21.5 ± 1.2	*2w PO - 4wPO*	p<0,001	18.8 ± 3.3	*2w PO - 4wPO*	p>0,05
	4wPO	16.1 ± 1.3	*4w PO - 6wPO*	p>0,05	16.1 ± 3.3	*4w PO - 6wPO*	p>0,05
	6wPO	14.5 ± 1.3	*6w PO - 3mPO*	p>0,05	14.1 ± 3.3	*6w PO - 3mPO*	p>0,05
	3m PO	13.8 ± 1.3	*3m PO - 6mPO*	p>0,05	15 ± 3.3	*3m PO - 6mPO*	p>0,05
	6mPO	13.3 ± 1.3			13.4 ± 3.3		
QuickDash-sport	pre-operative	16.2 ± 0.6	*pre-op - 2w PO*	p<0,001	15.3 ± 2.0	*pre-op - 2w PO*	p<0,05
	2w PO	9.6 ± 0.6	*2w PO - 4wPO*	p<0,05	11.6 ± 2.0	*2w PO - 4wPO*	p>0,05
	4wPO	6.5 ± 0.6	*4w PO - 6wPO*	p<0,05	7.8 ± 2.0	*4w PO - 6wPO*	p>0,05
	6wPO	5.5 ± 0.6	*6w PO - 3mPO*	p>0,05	6.6 ± 2.0	*6w PO - 3mPO*	p>0,05
	3m PO	4.8 ± 0.6	*3m PO - 6mPO*	p>0,05	7.4 ± 2.0	*3m PO - 6mPO*	p>0,05
	6mPO	5.1 ± 0.6			5.1 ± 2.0		
NRS (rest)	pre-operative	3.6 ± 0.2	*pre-op - 2w PO*	p<0,001	4.1 ± 0.5	*pre-op - 2w PO*	p<0,05
	2w PO	1.0 ± 0.2	*2w PO - 4wPO*	p>0,05	1.2 ± 0.5	*2w PO - 4wPO*	p>0,05
	4wPO	0.5 ± 0.2	*4w PO - 6wPO*	p>0,05	0.8 ± 0.5	*4w PO - 6wPO*	p>0,05
	6wPO	0.3 ± 0.2	*6w PO - 3mPO*	p>0,05	0.6 ± 0.5	*6w PO - 3mPO*	p>0,05
	3m PO	0.2 ± 0.2	*3m PO - 6mPO*	p>0,05	0.6 ± 0.5	*3m PO - 6mPO*	p>0,05
	6mPO	0.3 ± 0.2			0.6 ± 0.5		
NRS (move)	pre-operative	6.2 ± 0.3	*pre-op - 2w PO*	p<0,001	6.0 ± 0.7	*pre-op - 2w PO*	p<0,05
	2w PO	2.2 ± 0.3	*2w PO - 4wPO*	p<0,05	2.3 ± 0.7	*2w PO - 4wPO*	p>0,05
	4wPO	1.2 ± 0.3	*4w PO - 6wPO*	p>0,05	1.3 ± 0.7	*4w PO - 6wPO*	p>0,05
	6wPO	0.7 ± 0.3	*6w PO - 3mPO*	p>0,05	1.0 ± 0.7	*6w PO - 3mPO*	p>0,05
	3m PO	0.4 ± 0.3	*3m PO - 6mPO*	p>0,05	1.0 ± 0.7	*3m PO - 6mPO*	p>0,05
	6mPO	0.6 ± 0.3			0.8 ± 0.7		

A significant decrease in Quick dash cyclists scores between preoperative (33 ± 1.2) and 2 weeks PO (21.5 ± 1.2) and between 2- and 4-weeks PO (16.1 ± 1.3) was found. If we look at the QuickDash scores of the motocross riders, a statistically significant improvement from preoperative (31.6 ± 3.3) to 6 weeks PO (14.1 ± 3.3) was seen. For the Quick-dash-sport, a significant improvement was found between pre-op and 2w PO ($p<0.001$), 2w and 4w PO ($p<0.05$) and 4w and 6w PO ($p<0.05$) for the cyclists. For the motocross riders the Quick-dash sport results were significantly improved between pre-operatively (15.3 ± 2.0) and 6w PO (6.6 ± 2.0).

NRS scores in rest for cyclists decreased significantly from 3.6 ± 0.2 to 1.0 ± 0.2 after two weeks. NRS scores during movement declined from 6.4 ± 0.3 preoperative to 1.2 ± 0.3 after 4 weeks PO. NRS score in rest and movement for motocross riders improved significantly from pre-operative (NRS_{rest}: 4.1 ± 0.5, NRS_{act}: 2.3 ± 0.5) to 2 weeks PO (NRS_{rest}: 1.2 ± 0.5, NRS_{act}: 2.3 ± 0.7).

In our patient population, 79.9% (n = 22) of cyclists and 43% (n = 3) of motocross riders resumed their indoor training during the first 2 weeks. At the same time, 50% (n = 14) of cyclists and 29% (n = 2) of motocross riders took up outside training. Return to competition was possible for 15% (n = 4) of the cycling professionals and 14% (n = 1) of the motocross riders after 2 weeks. Due to the covid pandemic and the suspension of all group sport competitions, 21% (n = 6) of cyclist and 14% (n = 1) of motocross riders could not return to competition although physically able (Table III).

After 4 weeks, 93% (n = 25) of cyclists and 57% (n = 4) of motocross riders trained outside, 21% (n = 6) of cyclists and 29% (n = 2) of motocross riders returned to competition. Of the competitive cyclists, 33% (n = 9) indicated that they were fit for competition but couldn't due to Covid-19 sport suspension.

Six weeks after the initial trauma, 100% (n = 28) of cyclists trained in- and outdoors and 57% (n = 4) of motocross riders trained indoors and 71% (n = 5) on the track. A total of 56% (n = 15) of cyclists and 57% (n = 4) of motocross riders returned to competition and another 36% (n = 10) would have started competition if it wasn't cancelled.

No further improvement was noted for cyclists but at 3 months, all motocross riders trained indoors and 72% (n = 5) trained and restarted competition. (Fig. 1).

One plate had to be revised because of an aseptic loosening (2.3%). One motorcyclist sustained an acromioclavicular joint dislocation of the ipsilateral shoulder 2 months after the operation because of a new trauma. He underwent an open reconstruction of the coracoacromial ligaments with a suspensory fixation system. In total, 5 plates were removed because of hardware prominence and irritation of the plate after request of the patient. Average time of plate removal was 6.8 ± 5.8 months postoperative (range: 1-18 months PO). On the final X-rays there were no non-unions or delayed unions to report.

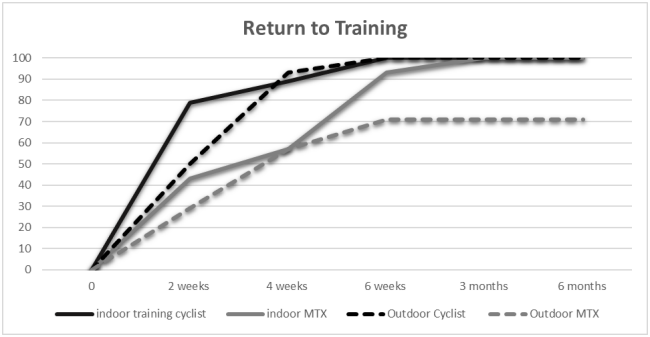

Figure 1 — Return to indoor (full line) and outdoor (dotted line) training after ORIF clavicle for cyclists (black) and motocross riders (MTX/grey) at all time points (2/4/6 weeks and 3/6 months postoperative).

Table III. — Return to sport (indoor training, outdoor training and competition) percentage for cyclists and motocross riders at all time points (2/4/6 weeks and 3/6 months postoperative). The closed brackets sign () marks the percentage of athletes that wanted to return to competition but were not in the possibility due to Covid-19 competition restrictions.

	Cyclists	*Motocross Riders*
2 weeks		
Indoor training	*79%*	*43%*
Outdoor training	*50%*	*29%*
Competition	*15%*	*14%*
4 weeks		
Indoor training	*89%*	*43%*
Outdoor training	*93%*	*57%*
Competition	*21% (+ 46%)*	*29%*
6 weeks		
Indoor training	*100%*	*57%*
Outdoor training	*100%*	*71%*
Competition	*56% (+36%)*	*57.0%*
3 months		
Indoor training	*100%*	*100%*
Outdoor training	*100%*	*71%*
Competition	*56% (+36%)*	*72% (+14%)*
6 months		
Indoor training	*100%*	*100%*
Outdoor training	*100%*	*71%*
Competition	*56% (+36%)*	*72% (+14%)*

DISCUSSION

This study focusses specifically on early results after operative treatment of midshaft clavicle fractures in

two homogeneous groups of athletes (elite cyclists and motocross riders). Our results show a drastic improvement in both pain and functional outcome scores in the first 2 weeks postoperative. Our return to sport time also shows that on average, 75% of cyclists and motocross riders were able to perform outdoor training 4 weeks postoperative and, not taking the limitations of the corona pandemic into consideration, an average of 92% of the cyclists and 57% of the motocross riders were able to ride competition at 6 weeks postoperative.

Many studies fail to evaluate the functional outcome of athletes, who have been treated with a rigid plate fixation for a clavicle fracture, in the very early postoperative setting. Ranalletta et al.[17] performed a comparable study on a heterogeneous group of 54 athletes and only reported functional outcome scores at final follow-up (μ: 22.4 months, range: 14-49 months). The mean Quick-Dash score was 0.4 ± 4.7 (range 0-7.1) and VAS pain score was 0.29 ± 1.0 (range 0-5). The average mean time to return to sports was 68 days (range, 5-180). They used a postoperative protocol which was much more restrictive than ours, as full range of movement of the affected arm was only allowed after 8 weeks. In another retrospective case series of 30 athletes of various sports, Meisterling et al. (9) found an average time to return to sports of 83 days (range 13-277). Rehab started immediately after the operation, but patients could only return to sports if the fracture was united, they had full range of movement and full strength. A study by Annicchiarico et al. of 32 non-athletes with a middle third clavicle fracture only reported the Dash-score (μ: 42, range: 38-99) one year after surgery[18].

Our results show that a large number of cyclists are already training indoors and outdoors 2 weeks postoperative (79% and 50%). After 4 weeks, almost all riders resumed full training outside (93%). At 6 weeks postoperative, competition was possible for 92% of cyclists and 57% of motocross riders. Haeberle et al.[19] studied the injuries which lead to withdrawal of cyclists in the Tour de France. A fracture was the most common cause (49%) and almost half of the fractures were clavicular. The reported return to competition time was on average 5.5 weeks, which is in line with our results for cyclists. V.D.J.C. Van der et al.[20] investigated the return to athletic activity after an anteroinferior plating of the clavicle in a group of cyclists (n=25) with middle and distal type fractures. Their results showed that all cyclists could train after 10 days and return to competition after 3 weeks. Recreational cyclists had an average of return to outdoor sport after 2 to 6 weeks. Compared to our own results this is a shorter return to sport time. The QuickDASH score reported at 6 weeks and 6 months was similar to our own results. The reported complication ratio was slightly higher (8%) compared to our study data (2.3%). The complication definition was in large lines the same for both studies though refracture was not included in our study and hematoma, ecchymosis, neurological symptoms and joint stiffness was not mentioned in the study of V.D.J.C. Van der et al.[20].

This is the first study to report the return to sport time after a clavicle fracture in motocross riders. Motocross riding is far more demanding for the shoulder girdle than bicycle riding. This is translated in a more prudent return to sports time, although all patients received the same postoperative advice: “Start training as pain allows”. After 2 weeks, almost one third was training outside and after 4 weeks more than half. All but one rider picked up racing on track after 6 weeks. This patient stopped motocross racing after his injury. Although he had good function and no pain, the fear of suffering another blow made him not psychologically ready to start racing again.

Despite the fact that athletes weren’t protected after the operation and could mobilise and train as pain allowed, we only had one major complication (aseptic loosening). In a study of Hebert-Davies of 15 NHL athletes, there were no complications seen in the operative group after plate fixation for a midshaft clavicle fracture[21]. We believe that a solid anatomical reduction is paramount to let the athlete move and train as pain allows and lower the risk of complications. Although there is always a potential risk of re-fracturing or wound infection after a plate fixation of the clavicle, we believe that waiting for complete healing of the wound or union of the bone is unnecessary.

Our study has a few limitations. The first limitation is the low sample size of motocross riders in our study, which complicates the statistical significance of their results. Secondly, our study was conducted during the Covid-19 pandemic and a lot of competitions were cancelled. As such, the real time to competition was hard to assess and our results almost certainly underestimate the return to competition outside pandemic conditions. Finally, we have no control group of athletes with collar bone fractures which were conservatively treated or more restrictively rehabilitated. As this study is focussed on high range athletes, it is quite difficult to establish a control group population where patients must possibly wait longer before they can start training.

CONCLUSION

This is the first study to report on functional outcome scores in the first 6 weeks after a midshaft clavicle surgery for a homogeneous group of elite athletes. This study shows that rapid operative management with early mobilisation is a safe and effective technique. We report good functional outcomes, a fast return time to training and competition and a low rate of complications. The results shown in this study could be used to inform cyclists and motocross riders on what to expect in the first weeks after surgery.

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