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In non-elite athletes, women are more likely to return to sports after anterior cruciate ligament reconstruction: a retrospective cohort study

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Abstract

Background The desire to return to sports (RTS) and return to performance at preinjury level (RTSP) is a common motivator for athletes undergoing anterior cruciate ligament (ACL) reconstructive surgery. However, for non-elite athletes little is known about the patient and surgical variables influencing RTS/RTSP. Purpose was to determine which patient or surgical variables had an effect on RTS/RTSP in non-elite athletes. We also analyzed whether patients that RTS and RTSP have more confidence in the knee and less difficulty pivoting.

Methods A single-centre retrospective cohort study. All patients who had undergone primary hamstring ACL reconstruction within a 5-year period were included. Patients were asked about their pre- and postoperative sports participation using the Tegner Activity Score (TAS) as well as about their RTS/RTSP. Confidence in the knee and difficulty with pivoting were asked about. To determine the potential adverse effect of patient variables at the time of surgery (sex, age, height, weight, TAS preop) and surgical variables (graft diameter, surgical technique, concomitant injury) influencing RTS/RTSP, univariate and multivariate logistic regression analysis were used.

Results 370 ACL reconstructions were included. Average follow-up was 4.6 years (SD 1.4). RTS rate was 65% and RTSP 43%. Median preinjury TAS was 7 (Q1:6, Q3:8)), postoperative 6 (Q1:4, Q3:7). Multivariate analysis showed that women were more likely to RTS (OR 2.40, 1.16–4.97). A lower preinjury TAS (OR 0.80, 0.67–0.95) resulted in higher RTSP levels. None of the surgical variables had a significant influence on RTS or RTSP. Patients who returned to sports or to preinjury-level performance displayed significantly more confidence in the operated knee and less difficulty pivoting than non-returning patients.

Conclusion Our study shows that 65% of non-elite athletes with an ACL reconstruction returned to sports, 43% at preinjury level. Women were over twice more likely to RTS than men. Preinjury TAS significantly influences RTSP, with

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a lower preinjury TAS leading to a higher percentage of RTSP. Patients returning to both scored better in their self-reported confidence in the knee and difficulty pivoting than non-returning patients.

Level of evidence Retrospective cohort III.

Key terms Anterior cruciate ligament, Reconstruction, Return to sport, Return to level of sports, Patient variables, Surgical variables

Background

The desire to return to sports (RTS) activity is a common motivator for athletes undergoing ACL reconstructive surgery. Multiple studies show a 67–88% RTS rate for elite athletes [1, 2]. Although the RTS rate seems relatively high, the rate for return to performance at preinjury level (RTSP) or above is lower, at 63–67% [1, 2, 4]. Several patient and surgical variables have shown to play a role in RTSP, such as sex, age, preinjury sports level, and additional intra-articular pathology [3–6]. Most studies on this topic have investigated RTS in elite athletes and only a few in non-elite athletes [2, 7–9]. In that sense, it can be questioned whether RTS/RTSP in non-elite athletes is influenced by the same patient and surgical variables as in elite athletes.

Several studies have looked at RTS for non-elite athletes. Most examined the RTS rate in comparison to elite athletes. However, only a few studies have specifically looked at variables influencing RTS in non-elite athletes. Legnani et al. showed that for amateur sportsmen, younger age at the time of ACL reconstruction positively affected RTS [12], but RTS was defined as any form of sports. Ardern et al. found that 67% of patients attempted some form of sports activity by 12 months postoperatively and 33% attempted competitive sports [2]. Keays et al. compared RTS after ACL reconstruction versus no reconstruction: looking at a wide range of sports activity, the reconstructed group reported 96% RTS and only 53% RTSP [7]. Recently, Webster et al. showed that 78% of non-elite male athletes who participate in Australian Rules football return to some level of play after primary ACL reconstruction surgery, yet only 64% RTSP [8]. Patel et al. showed that 56.4% of non-elite athletes RTS and that this was influenced by a combination of activity level, sport, self-reported knee instability, and psychosocial factors [9]. Other studies have examined physical and psychological readiness to RTS, which was seen to lead to a higher percentage of RTSP [10, 11].

As knowledge about RTS and especially RTSP remains scarce in non-elite athletes, purpose of this study was to analyze which patient or surgical variables have an effect on RTS and RTSP in non-elite athletes after ACL reconstruction using hamstring graft. We also assessed whether confidence in the knee and difficulty pivoting differs between patients who RTS and RTSP. We hypothesized that patients who RTS/RTSP have more confidence in the knee and less difficulty pivoting than patients who do not RTS/RTSP.

Methods

Population

This is a single-centre retrospective cohort study. All patients at our hospital who underwent primary hamstring ACL reconstruction within a 5-year period were included. Patients needed a minimum follow-up of two years and had to be between ages 18–65 at the time of follow-up. Patients with multiligament reconstructions or an extra-articular procedure were excluded. Patients with missing surgical data were excluded.

Measurement instruments

Non-elite athletes were defined as any athlete practising any form of sports. Elite athletes and patients who didn't practise any sport preinjury (TAS 0–2) were excluded. Elite athletes were defined in line with Lai et al. (2018) [3] as people playing sports professionally, or at the highest possible competitive level for their sport, professional or amateur. All ACL reconstructions between 1 January 2010 and 31 December 2014 were screened for inclusion. Patients who met the inclusion criteria were contacted by phone by an independent assessor. After obtaining oral consent, patients were interviewed about their RTS/RTSP. RTS was defined as return to the same sports activity as preinjury. RTSP was defined as patient-subjective self-assessment of successful return to performance at the same level of sport or higher. This is in line with the most commonly used definition as described by Marom et al. [13]. Patients were asked if they ever returned to sports or to performing at preinjury level after surgery.

Preinjury and postoperative sports activity level was rated using the Tegner Activity Scale (TAS) [14]. Patient characteristics and surgical details were obtained from hospital records. The following patient variables were collected: sex, age, height, weight, and body mass index (BMI) at the time of surgery. The surgical variables were surgical technique, concomitant knee injury, graft diameter, and type of femoral and tibial fixation.

Confidence in the knee and difficulty pivoting were scored using two questions from the Knee Injury and Osteoarthritis Outcome Score (KOOS) (Q3, P2) [15]. The questions were scored on a 5-point scale (0–4: confidence in the knee: 0 = complete, 1 = largely, 2 = moderate,

3=some, 4=none; difficulty pivoting: 0=none, 1=mild, 2=moderate, 3=severe, 4=extreme). Scores of 0 and 1 were regarded as a good result. The study was approved (METc nr: 16.06105) by the local Medical Ethics Committee of University Medical Center Groningen (IRB00002056).

Surgical procedure

Due to an institutional change in treatment protocol, two surgical techniques were performed. Transtibial (TT) and anteromedial portal (AMP) hamstring reconstruction techniques were used [16], with ipsilateral semitendinosus and gracilis hamstring tendons. The TT technique is a non-anatomical ACL reconstruction. The graft is fixated using the transfix on the femoral side and an interference screw on the tibial side (Arthrex Inc., Naples, FL, USA). The AMP is an anatomical ACL reconstruction technique. The graft is fixated using an endobutton on the femoral side and an interference screw on the tibial side (Smith & Nephew, Andover, MA, USA). After ACL reconstruction a uniform postoperative rehabilitation protocol was prescribed. This protocol followed the guidelines of the Dutch Physiotherapy Association (KNGF). The rehabilitation protocol consists of a staged protocol with 3 phases. The duration of the phases isn't fixed and depends on the progress of the patient.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics 24 (IBM Armonk, NY, USA). Descriptive statistics (mean, *N* (%), 95% CI) were used to describe demographic characteristics, postoperative RTS/RTSP, and pre- and postoperative sports activity level. Univariate and multivariate logistic regression analysis was used for patient variables (sex, age, height, weight, TAS preop) and surgical variables (graft diameter, surgical technique, concomitant injury) influencing RTS/RTSP. First RTS/RTSP and each variable (both patient and surgical) were univariately assessed. Second, all variables were included in the multivariate model and analyzed through a stepwise backwards likelihood ratio model. The Chi-square test was performed to determine if confidence in the knee and difficulty pivoting differed between patients that RTS and RTSP. *P*-values <0.05 were considered statistically significant.

Results

Population

Between 2010 and 2014 there were 647 primary ACL hamstring reconstructions (638 patients), with 28 patients excluded due to failure of their ACL reconstruction. Of these remaining reconstructions, 537 (86.8%) had full surgical data available. We were able to contact 392 (73%) of these patients for additional questionnaires (Fig. 1), and excluded 22 of them because they didn't practice any sport preinjury (TAS 0–2) or were elite athletes. The remaining 370 ACL reconstructions were included. Average follow-up was 4.6 years (SD 1.4 years). The demographic characteristics are shown in Table 1.

Population

RTS rate was 65% and RTSP 43%. Median preinjury TAS for male and female patients was 7 (Q1:7, Q3:9) and 6 (Q1:6-Q3:7), postoperative 6 (Q1:5, Q3:6) and 6 (Q1:4-Q3:6), respectively. The change between preinjury and postoperative TAS for both groups together is illustrated in Table 2.

Table 3 shows the results of the univariate and multivariate regression analyses of the patient and surgical variables. Based on the univariate analysis, none of the patient or surgical variables have a significant influence on RTS. The multivariate analysis shows that women were more likely to RTS (OR 2.40, 1.16–4.97). Preinjury TAS significantly influences RTSP, with a lower preinjury TAS (OR 0.80, 0.67–0.95) leading to a higher level of RTSP.

The outcomes of the questions informing on confidence in the knee and difficulty pivoting were compared to RTS/RTSP (Table 4). Patients unable to RTS/RTSP show having significantly less confidence in the operated knee and more difficulty pivoting.

Discussion

The most important findings of the present study are that women are over twice more likely to RTS (OR 2.40) than men. RTSP was influenced by preinjury TAS, with a lower preinjury TAS leading to a higher percentage of RTSP (OR 0.80). This shows that participation in sports on a lower level obviously makes it easier to return to the same level. Surgical variables did not influence RTS/RTSP. In addition, the results show that patients who returned to sports or to preinjury-level performance scored significantly better in their self-reported confidence in the knee and had less difficulty pivoting than non-returning patients.

Our results show that 65% of patients returned to sports and 43% did so at preinjury level. Median preinjury TAS in our population was 7 and 6 for males and females, respectively, and postoperatively 6 for both. The pattern for the shift in preoperative to postoperative TAS scores is more or less the same for both too. RTS/RTSP in our study are comparable to those of Ardern et al. [2], who found 67% of patients attempted some form of sports activity by 12 months postoperatively and 33% attempted competitive sports, although they concluded that people may require a postoperative rehabilitation period longer than 12 months. Our study has a follow-up

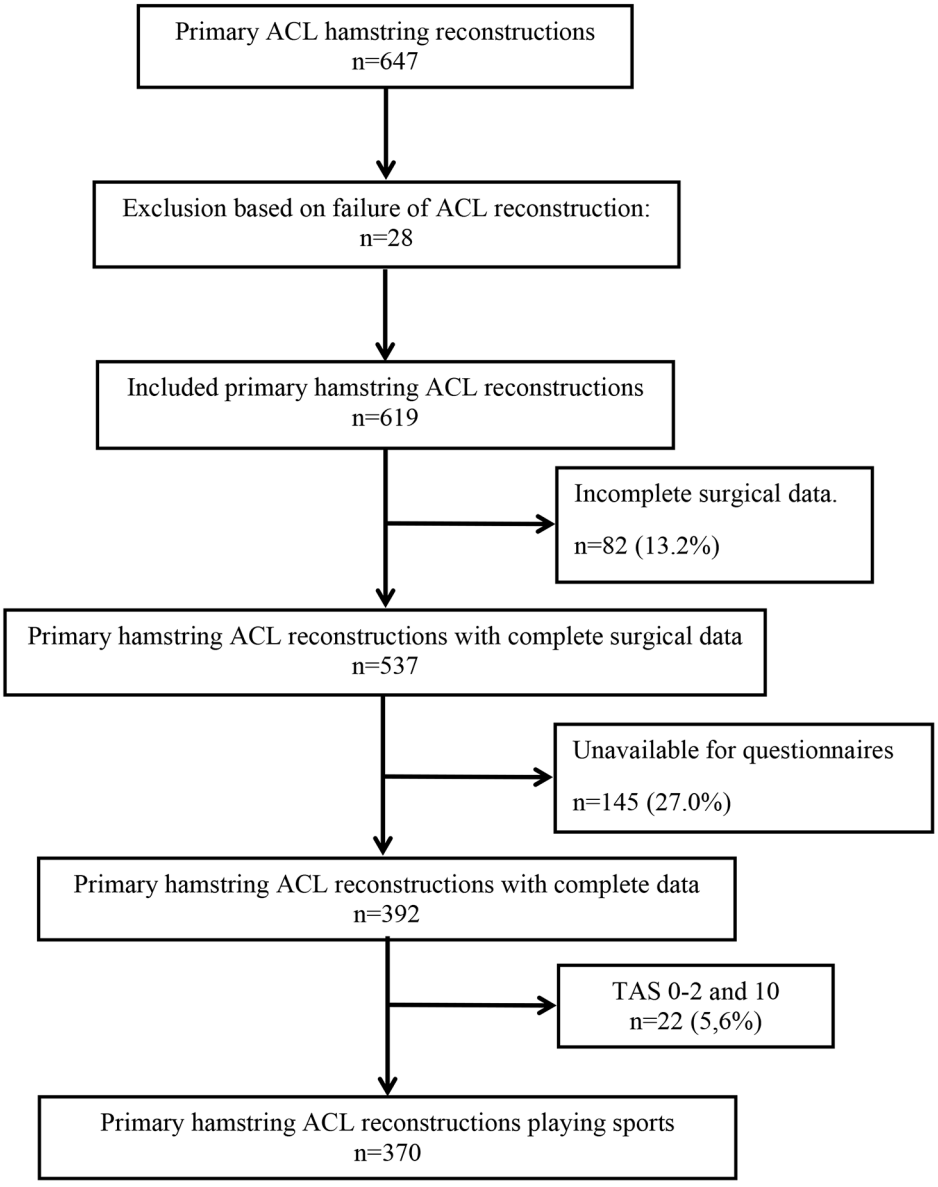

Fig. 1 Flow chart of the numbers of patients that were excluded and included for the primary hamstring ACL reconstructions with complete data

Table 1 Demographic characteristics

	Male *n* = 247	Female *n* = 123	Total *n* = 370
Age, years *	29.5 (15–56)	28.8 (14–59)	29.2 (14–59)
Height, cm *	182 (161–202)	171 (142–191)	179 (142–202)
Weight, kg *	83 (52–135)	72 (45–111)	79 (45–135)
BMI *	24.9 (17.8–35.5)	24.8 (18.2–41.5)	24.9 (17.8–41.5)
TAS preinjury **	7 (Q1:7-Q3:9)	6 (Q1:6-Q3:7)	7 (Q1:7-Q3:8)
TAS postoperative **	6 (Q1:5-Q3:6)	6 (Q1:4-Q3:6)	6 (Q1:4-Q3:7)

*Mean (range), **Median (25–75%)

of 4.6 years and shows similar RTS/RTSP results, but we also included recreational athletes.

For range of sports activity, our study is comparable to that of Keays et al. [7], although at 8.2 their preinjury TAS was higher. They also looked at a wide range of sports activity, reporting 96% RTS and 53% RTSP in their reconstructed group, but defining RTS as returning to any form of sports. When looking at patients participating in the same sports as preinjury, they reported a RTS of 63%, which is similar to our results.

Our results on variables influencing RTS/RTSP in non-elite athletes can only be compared to a few other studies. Patel et al. conducted a study similar to ours. They showed that 56.4% of non-elite athletes returned to

Table 2 Number of patients with preinjury and postoperative tegner activity score (TAS)

Tegner Activity Score		Preop	Postop
10	Competitive sports (national elite): soccer, football, rugby	0	
9	Competitive sports (lower divisions) soccer, football, rugby, ice hockey, wrestling, gymnastics, basketball	76	33
8	Competitive sports: racquetball, squash, badminton, track and field athletics, downhill skiing	29	26
7	Competitive sports: tennis, running, motorcars, speedway, handball. Recreational sports: soccer, football, rugby, ice hockey, basketball, squash, racquetball, running	143	84
6	Recreational sports: tennis, badminton, handball, racquetball, downhill skiing, jogging at least 5x per week	56	64
5	Work: heavy labour (construction, etc.) Competitive sports: cycling, cross-country skiing Recreational sports: jogging on uneven ground at least twice weekly	27	70
4	Work: moderately heavy labour (e.g. truck driving) Recreational sports: cycling, cross-country skiing, jogging on even ground at least twice weekly	24	53
3	Work: light labour (e.g. nursing) Competitive and recreational sports: swimming, forest hiking possible	15	29
2	Walking on uneven ground possible, backpacking or hiking impossible	0	10
1	Work: sedentary (e.g. administrative)	0	0
0	Sick leave or disability pension because of knee problems	0	1

sports, and that this was influenced by a combination of activity level, sport, self-reported knee instability, and psycho-social factors [8]. They had a similar pre- and postoperative TAS compared to our study. Klasan et al. looked at RTS using the results of an RTS assessment and self-reported questionnaires [17]. They concluded that preinjury TAS can aid in objectively predicting patients' RTS after two years, with high-level athletes more likely to return to their previous sport and level. This is different from our results, but Klasan et al. only included patients who had returned to sports.

Our study shows that patients who RTS/RTSP score much better in their self-reported confidence in the knee and difficulty pivoting than non-returning patients. Rauck et al. asked a question similar to ours, and concluded that patients with higher confidence in performance of the reconstructed knee were more likely to RTSP [18]. Faleide et al. showed that age and psychological readiness measured nine months after surgery were found to be predictors of RTS two years after ACLR, while functional tests had no predictive value [19]. Webster et al. studied psychological readiness to RTS after ACL surgery [11], revealing that self-reported symptoms and function were most associated with psychological readiness, which was higher in male patients who participated frequently in sports before ACL injury. Ardern et al. showed that psychological readiness to RTS was the factor most strongly associated with RTS [10], with less than 50% patients returning to their preinjury sport or recreational activity after ACL reconstruction.

Our results also show that the majority of patients who didn't RTS had confidence in the knee (0–1; 61.8%) and no difficulty pivoting (0–1; 80.2%). The same holds true for patients who didn't RTSP, had confidence in the knee (0–1; 68.2%), and had no difficulty pivoting (0–1;82.9%). This may point to other reasons why patients do not RTS/RTSP after ACL surgery. Patel et al. already showed that fear of re-injury, lack of confidence, lack of time, and change in job were significantly more important to the group that didn't RTS [8], whereas giving way and change in job were independent predictors to not RTS. Kiran at al. investigated RTS after revision ACL, showing that lack of interest, time, and life events play an important role influencing non-return to sports [20]. This might also be the reason for RTS/RTSP being lower in non-elite athletes compared to elite athletes.

The strength of the current study is that we performed a multivariate analysis that included both patient and surgical variables. Several limitations of our study should be mentioned. First of all, a power analysis was not done. A power analysis has to be based on an expected difference or effect. However, as not much information is out in the literature about what can be expected, a well-founded hypothesis was not possible. Secondly, this is a retrospective analysis, so we weren't able to assess time to RTS. Moreover, self -reported questionnaires were used, which could have let to bias. As the rehabilitation is done outside the hospital we have no control over rehabilitation compliance. The average follow-up was 4.6 years, which may have led to a somewhat lower RTS and RTSP. There might be a natural decline in sports activity with ageing and during our follow-up. The study of Ardern et al showed that 61% of their study sample attempted to RTSP at some time after their ACL reconstruction [21]. At follow-up at 39.9 months 45% had RTSP. We didn't analyze time of RTS – due to the follow-up of 4.6 years we deemed this unreliable. Finally, there might be a risk of bias due to graft selection. However, we think this risk is very limited. During the study there were no primary ACL reconstructions with patella, tendon, or other autografts. There were only 17 primary ACL reconstructions with allografts. With respect to measuring confidence

Table 3 Univariate and multivariate analysis of variables affecting RTS/RTSP after ACL reconstruction

		Return to sport						Return to performance					
		Univariate			Multivariate			Univariate			Multivariate		
		OR	95% CI	*p*-value	OR	95% CI	*p*-value	OR	95% CI	*p*-value	OR	95% CI	*p*-value
		Patient variables											
Sex	- Male 247	--	--	0.128	--	--	**0.019**	--	--	0.112	--	--	0.360
	- Female 123	1.419	0.893–2.254		2.40*	1.16–4.97		1.481	0.96–2.30		1.38	0.69–2.76	
Age		1.004	0.984–1.025	0.597	1.00	0.98–1.03	0.776	1.02	0.99–1.04	0.232	1.01	0.98–1.04	0.582
Height		1.008	0.983–1.034	0.496	0.97	0.81–1.17	0.776	1.00	0.98–1.03	0.916	0.99	0.84–1.18	0.909
Weight		1.008	0.992–1.025	0.175	1.07	0.87–1.32	0.519	1.00	0.98–1.01	0.952	1.02	0.84–1.23	0.843
TAS preinjury		0.887	0.774–1.017	0.203	0.99	0.82–1.18	0.892	0.75*	0.65–0.86	**<0.01**	0.80*	0.67–0.95	**0.013**
		Surgical variables											
Graft diameter		1.181	0.836–1.669	0.401	1.23	0.80–1.88	0.341	0.96	0.68–1.34	0.927	1.07	0.71–1.62	0.750
Surgical technique	- TT 153	0.865	0.562–1.332	0.685	1.10	0.66–1.84	0.714	1.00	0.66–1.52	0.192	1.31	0.79–2.16	0.292
	- AMP 217	--	--		--	--		--	--		--	--	
Accompanying injury	- Cartilage 34	0.86	0.40–1.85	0.934	0.53	0.20–1.40	0.794	0.81	0.38–1.72	0.608	0.42	0.15–1.16	0.690
	- Meniscus 140	0.960	0.60–1.54	0.626	0.79	0.45–1.37	0.201	1.03	0.66–1.63	0.173	0.91	0.53–1.58	0.093
	- Medial collateral ligament 3	1.07	0.10-12.02	0.686	0.38	0.02–6.77	0.395	0.65	0.06–7.31	0.827	1.00	0.06–17.50	0.739
	- Cartilage & meniscus 31	1.12	0.49–2.54	0.704	0.65	0.24–1.73	0.508	1.07	0.49–2.32	0.825	0.70	0.26–1.87	0.998
	- None 162	--	--	0.704	--	--	0.737	--	--	0.224	--	--	0.999

* significant difference, TT: transtibial surgical technique, AMP: anteromedial portal surgical technique

Table 4 Difference in patients' confidence in the knee and difficulty pivoting between patients who did RTS/RTSP and those who did not

		Confidence in the knee			Difficulty pivoting		
		Mean	**95% CI**	**0–1**	**Mean**	**95% CI**	**0–1**
RTS	No: $n=131$	1.31	1.15–1.46	61.8%	0.76	0.60–0.93	80.2%
	Yes: $n=239$	0.78	0.69–0.87	89.4%	0.34	0.26–0.43	93.8%
	P-value	< 0.01			< 0.01		
RTSP	No: $n=210$	1.18	1.06–1.30	68.2%	0.67	0.54–0.79	82.9%
	Yes: $n=160$	0.69	0.58–0.80	89.4%	0.26	0.17–0.35	93.8%
	P-value	< 0.01			< 0.01		

0–1: percentage of patients that score 0 or 1 on confidence in the knee and difficulty pivoting

in the knee and difficulty pivoting, two questions out of the KOOS questionnaire were used, although these were not tested for validity separately but as part of the KOOS. Based on the straightforward formulation of both items, it was assumed that respondents could answer these questions in a valid way.

Conclusions

This study shows that 65% of non-elite athletes with an ACL reconstruction return to playing the same sports and 43% return to playing at the same level as before the injury; that women are more likely to RTS than men; and that preinjury TAS influences RTSP, where a higher preinjury TAS leads to a lower percentage of RTSP. In our study, patients who returned to sports or to preinjury-level performance scored much better in their self-reported confidence in the knee and difficulty pivoting than non-returning patients, yet a majority of the latter group had confidence in the knee and no difficulty pivoting.

Abbreviations

RTS Return to sports
RTSP Return to performance to preinjury sports level
ACL Anterior cruciate ligament
TAS Tegner Activity Score
TT Transtibial surgical technique
AMP Anteromedial portal surgical technique

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Author contributions

BR analyzed and interpreted the data and wrote the main manuscript text. MK collected the data. RZ designed the work and substantively revised the work. MS and SB substantively revised the work. We acknowledge that all authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and that all authors are in agreement with the manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available due institutional privacy guideline but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and must has been approved by an appropriate ethics committee. The local Medical Ethics Committee Isala Zwolle gave its approval, and due to the retrospective nature of the study it waived the need for written informed consent (METC no.: 16.06105).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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