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Original Research

Current perspectives of Australian therapists on rehabilitation and return to sport after anterior cruciate ligament reconstruction: A survey

Jay R. Ebert [a, b, *], Kate E. Webster [c], Peter K. Edwards [a, b], Brendan K. Joss [b], Peter D'Alessandro [d], Greg Janes [e], Peter Annear [e]

[a] School of Human Sciences (Exercise and Sport Science), University of Western Australia, Crawley, Western Australia, Australia
[b] HFRC Rehabilitation Clinic, Nedlands, Western Australia, Australia
[c] School of Allied Health, La Trobe University, Melbourne, Victoria, Australia
[d] Coastal Orthopaedics, Bethesda Hospital, Claremont, Western Australia, Australia
[e] Perth Orthopaedic and Sports Medicine Centre, West Perth, Western Australia, Australia

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ABSTRACT

Objectives: To investigate views and practices of Australian therapists on rehabilitation and return to sport (RTS) after anterior cruciate ligament reconstruction (ACLR).
Design: Survey-based study.
Setting: Online survey platform.
Participants: Australian Physiotherapists and Accredited Exercise Physiologists (n = 223).
Main outcome measures: 1) perceived benefit, timing and frequency of rehabilitation, 2) timing of RTS and information on RTS evaluation and discharge criteria.
Results: Therapists preferred to consult patients for the first time at 1–4 days (27.8%), ≤7 days (25.6%) or 7–14 days (30.5%) post-surgery. Within the first 6 weeks, 82.1% of therapists preferred patient visitation 1–2 times per week. Between 3 and 6 months, therapists mainly recommended less frequent visitation with a focus on home exercises. While 22.0% and 53.8% of therapists were willing to discharge patients for sport at 6–9 and 9–12 months, respectively, 22.9% preferred 12–18 months. Common RTS considerations were functional capacity (98.7%), strength (87.0%), lower limb and trunk mechanics (96.0%) and psychological readiness (87.9%). Knee strength was evaluated via manual muscle testing (33.0%), hand held (26.7%) and isokinetic (11.8%) dynamometry. For functional evaluation, 84.3% of therapists employed a hop battery (≥2 hop tests).
Conclusions: This survey revealed variation in beliefs and practices surrounding rehabilitation and RTS evaluation in Australian therapists.

1. Introduction

Anterior cruciate ligament (ACL) ruptures are common, particularly during sports involving cutting, landing and pivoting movements, with a reported annual incidence of 68.6 per 100,000 person-years (Sanders et al., 2016). Surgical ACL reconstruction (ACLR) is currently considered the standard clinical treatment (Shea et al., 2015), and a recent study reported that Australia has the highest incidence of ACLR in the world (Zbrojkiewicz, Vertullo, & Grayson, 2018). This study reported a 43% annual increase in the incidence of ACLR between 2000 and 2015 from 54.0 to 77.4 (per 100,000 population), and by 74% in patients under 25 years from 52.6 to 91.4 (Zbrojkiewicz et al., 2018). The primary goals of ACLR are to maximise knee stability and functional capacity, whilst permitting a safe return to sport (RTS) (Ardern, Webster, Taylor, & Feller, 2011; Barber-Westin & Noyes, 2011), though a recent systematic review and meta analysis reported an overall secondary ACL injury rate of 15% (7% incidence on the ipsilateral side) with a 21% re-injury rate (10% incidence on the ipsilateral side) in those under 25 years (Wiggins et al., 2016).

* Corresponding author. School of Human Sciences (M408), The University of Western Australia, 35 Stirling Highway, Crawley, 6009, Western Australia, Australia.
E-mail address: jay.ebert@uwa.edu.au (J.R. Ebert).

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A consensus statement in 2016 reports a RTS continuum following injury or surgery, inclusive of: 1) return to participation (return to training though not yet deemed medically, physically or psychologically ready to return to RTS), 2) RTS (returned to the defined sport inclusive of games) and 3) return to performance (playing and performing at or above pre-injury level) (Ardern et al., 2016). A range of variables may influence the patient's ability and readiness to RTS, as well as their re-injury risk, including pre-operative (age, pre-operative rehabilitation, knee extension and neuromuscular control), intra-operative (graft choice) and post-operative (rehabilitation and psychological factors) factors (Irarrázaval, Kurosaka, Cohen, & Fu, 2016). Pre-operative rehabilitation aims to address musculoskeletal and range of motion deficits, as well as better prepare the patient physically and mentally for the surgical process, and a number of studies and reviews have demonstrated its positive effect on post-operative knee function and muscle strength (Alshewaier, Yeowell, & Fatoye, 2017; Eitzen, Holm, & Risberg, 2009; Eitzen, Moksnes, Snyder-Mackler, & Risberg, 2010; Failla et al., 2016; Grindem et al., 2015; Shaarani et al., 2013). Post-operative rehabilitation aims to address deficits in neuromuscular strength and limb loading strategies, which are suggested to be key components for reducing the risk of secondary injury (Paterno et al., 2010). A recent systematic review and multidisciplinary consensus has summarised the components of rehabilitation (van Melick et al., 2016), and a comprehensive test battery should also be employed in all patients prior to clearance for RTS (van Melick et al., 2016). The potential value of these test batteries has been demonstrated, with the emerging link between lower limb strength/functional asymmetry and an increased re-injury risk (Grindem, Snyder-Mackler, Moksnes, Engebretsen, & Risberg, 2016; Kyritsis, Bahr, Landreau, Miladi, & Witvrouw, 2016).

Several studies and reviews have been published over the last 5–10 years highlighting the importance and components of pre- and post-operative rehabilitation (Alshewaier et al., 2017; Eitzen et al., 2009, 2010; Failla et al., 2016; Grindem et al., 2015; Paterno et al., 2010; Shaarani et al., 2013; van Melick et al., 2016), as well as RTS testing prior to patient discharge (Grindem et al., 2016; Kyritsis et al., 2016; van Melick et al., 2016), though it is not known whether this evidence is being adopted by therapists who work with these patients to achieve their RTS goals. Therefore, this study sought to investigate current practice of Australian therapists on pre- and post-operative rehabilitation, as well as RTS discharge criteria and methods employed in evaluating patients prior to RTS.

2. Methods

A 15-item survey was developed upon discussion and collaboration between a group of Australian Physiotherapists, Accredited Exercises Physiologists (AEPs), orthopaedic surgeons and university academics, all with a clinical interest in ACLR and/or a focus in musculoskeletal and orthopaedic research. The survey was anonymous and this was made clear to respondents, with no identifying information collected. As an introduction to the survey, it was stated to respondents that the survey had been developed only for therapists actively working with patients before and after ACLR, irrespective of whether they were working with one patient or many on an annual basis. Respondents were asked to answer the survey questions based on their current practice with their ACLR patients. It was also clearly stated that if therapists were not working with these patients, they should not complete the survey. Upon development and internal administration of the survey, it was estimated and communicated to respondents that it would require 10 min to complete.

The survey questions and response items are shown in Table 1. In addition to basic respondent demographics and primary practice area (items 1–3), the survey sought to investigate information on the preferred post-operative timing and frequency of rehabilitation (items 4–6), current views on the importance of pre- (item 7) and post-operative (items 8–11) rehabilitation, timing of RTS discharge (item 12) and information on discharge criteria and methods of RTS and/or physical evaluation (items 13–15). A categorical response was sought for each question and only one item could be selected, apart from item 13 (RTS discharge criteria), item 14 (methods adopted to evaluate knee strength) and item 15 (methods adopted to evaluate lower limb functional capacity).

The survey was constructed and disseminated via an online platform (Survey Monkey), with a link to the survey provided to all members of the Australian Physiotherapy Association (APA) and Exercise and Sport Science Australia (ESSA). The APA is the peak member body representing Australian Physiotherapists, and ESSA is the peak member body representing Australian AEPs. The study information and survey link was made available via several avenues to members in both disciplines between February and June 2018, including the respective Members portals and of both groups, and State and National electronic news bulletins, in order to maximise survey exposure.

Following survey closure, the online platform permitted export of group and individual responses in Microsoft Excel format, where data could then be analysed. The percentage of respondents selecting each response within the 15 survey questions was tabulated. Further exploration was made into items that provided the option 'other (please specify)', to investigate other avenues that were being employed by therapists in clinical practice.

3. Results

A total of 223 therapists responded to the survey, with all survey items being completed by all respondents. Of the participant group, 84.8% (n = 189) had a clinical focus treating all musculoskeletal conditions, with 10.8% (n = 24) stating that their focus was specifically in the lower limb (Table 1). The majority (55.2%) of respondents estimated they worked with 6–20 ACLR patients annually, though 26% worked with 1–5, 15.7% with 20–50 and 3.1% with >51 patients each year (Table 1). All Australian geographical locations were represented (Table 1).

The majority of therapists expressed a desire to consult their patients for the first time following hospital discharge at 1–4 days (27.8%), ≤7 days (25.6%) or 7–14 days (30.5%) post-surgery, with a further 15.3% of therapists stating once the surgeon had cleared the patient to initiate out-patient rehabilitation (Table 1). As expected, the majority of therapists (95.5%) felt that pre-operative rehabilitation was important or essential for patients embarking on ACLR (Table 1), which was also the case for post-operative rehabilitation within the first 6 post-operative weeks (99.1%), within 6 weeks to 3 months (100%), within 3–6 months (99.5%) and from 6 months onwards (96.4%) (Table 1). However, the recommended frequency of rehabilitation visits varied, with visits twice per week (42.6%), once per week (39.5%) and once every two weeks (12.1%) reported most commonly within the first six post-operative weeks (Table 1). Between 3 and 6 months post-surgery, most therapists recommended less frequent visitation with a focus on home (or gym) based exercises with periodic review (40.4%), though 25.5% of therapists still recommended supervised visitation once or twice per week.

Providing individual discharge criteria were met, the majority of therapists (53.8%) were willing to discharge a patient for RTS at 9–12 months post-surgery (Table 1). However, 22.0% of therapists were willing to discharge patients at 6–9 months, with 22.9% waiting until 12–18 months (Table 1).

For RTS clearance, the most highly reported considerations were

Table 1
Responses (n, %) for each question within the 15-item anonymous survey provided to therapists.

Item	Question/Response	n	%	Item	Question/Response	n	%
1	What is your primary area of expertise for the purpose of this survey?			2	Approximately, how many ACLR patients would you see per year?		
	All musculoskeletal conditions (including orthopaedics)	189	84.8%		1–5	58	26.0%
	Primarily lower limb	24	10.8%		6–20	123	55.2%
	Primarily upper limb	0	0.0%		21–50	35	15.7%
	Other sub-specialty, but I still see some ACLR patients	10	4.5%		>51	7	3.1%
	Other (please specify)	0	0.0%				
3	Which state or territory do you practice in?			4	At what post-operative time-point do you encourage your patient to be seen by you after their ACLR surgery?		
	ACT	7	3.1%		Within the first 1–4 days after surgery	62	27.8%
	NSW	70	31.4%		Within the first 7 days after surgery	57	25.6%
	NT	2	0.9%		Between 1 and 2 weeks after surgery	68	30.5%
	SA	16	7.2%		After being cleared by their surgeon	34	15.3%
	TAS	3	1.4%		When they feel ready to start, though I do not recommend a specific (or ideal) time	2	0.9%
	WA	37	16.6%				
	VIC	48	21.5%				
	QLD	40	17.9%				
5	How often would you like to see your ACLR patient for supervised rehabilitation (within the first 6 weeks post-surgery)?			6	Between 3 and 6 months post-surgery, how often would you like to see your ACLR patient within your practice?		
	Twice per week	95	42.6%		Twice per week	19	8.5%
	Once per week	88	39.5%		Once per week	38	17.0%
	Once every two weeks	27	12.1%		Once every two weeks	74	33.2%
	Less frequently if possible, with a focus on home-based exercises and periodic review	11	4.9%		Less frequently if possible, with a focus on home (or gym) based exercises and periodic review	90	40.4%
	Other (please specify)	2	0.9%		Other (please specify)	2	0.9%
7	How important do you think 'pre-operative rehabilitation' is to post-operative patient outcome?			8	How important do you think 'post-operative rehabilitation' is to overall patient outcome within the first 6 weeks post-surgery?		
	Essential	124	55.6%		Essential	177	79.4%
	Important	89	39.9%		Important	44	19.7%
	Not important	5	2.2%		Not important	2	0.9%
	No view or opinion	5	2.2%		No view or opinion	0	0.0%
9	How important do you think 'post-operative rehabilitation' is to overall patient outcome within 6 weeks to 3 months post-surgery?			10	How important do you think 'post-operative rehabilitation' is to overall patient outcome within 3–6 months post-surgery?		
	Essential	188	84.3%		Essential	157	70.4%
	Important	35	15.7%		Important	65	29.2%
	Not important	0	0.0%		Not important	1	0.5%
	No view or opinion	0	0.0%		No view or opinion	0	0.0%
11	How important do you think 'post-operative rehabilitation' is to overall patient outcome from 6 months post-surgery onwards?			12	Providing you are satisfied with their progress and physical capacity, what time do you typically permit a patient to return to sport (including AFL, rugby, soccer, netball, hockey etc.)?		
	Essential	109	48.9%		6–9 months	49	22.0%
	Important	106	47.5%		9–12 months	120	53.8%
	Not important	8	3.6%		12–18 months	51	22.9%
	No view or opinion	0	0.0%		≥18 months	2	0.9%
					I tell them they should not return to higher demand sports (e.g. AFL, rugby, soccer, netball)	1	0.5%
13	Given the aforementioned high demand sports, what factors do you personally consider before 'clearing' a patient to return to their sport			14	If you consider 'knee strength' to be important prior to clearing a patient to return to their sport, how do you evaluate this?		
	Time from surgery	175	78.5%		I use manual muscle testing methods	73	33.0%
	Age of the patient	120	53.8%		I use hand held dynamometry	59	26.7%
	Knee Range of Movement and/or Laxity	155	69.5%		I use an isokinetic dynamometer	26	11.8%
	Side-to-side differences in muscular size (i.e. thigh girth)	122	54.7%		I extrapolate/estimate knee strength from other measures such as hop capacity	108	48.9%
	Patient-reported Outcome Questionnaires	102	45.7%		I do not consider these tests that important	1	0.5%
	Psychological readiness (e.g. confidence, anxiety)	196	87.9%		I feel strength is important, but do not have access to necessary equipment (and/or do not feel manual testing methods are accurate enough) so I refer on to someone who can provide such an evaluation for me	24	10.9%
	Knee Strength	194	87.0%				
	Functional capacity (e.g. jump and/or hop tests)	220	98.7%				
	Lower limb and trunk mechanics during jumping/landing tasks	214	96.0%				
	Other (please specify)	45	20.2%		Other (please specify)	25	11.2%
15	If you consider 'lower limb functional capacity' to be important prior to clearing a patient to return to their sport, how do you evaluate this?						
	Single limb hop for distance	11	4.9%				
	6 m timed hop test	1	0.5%				
	Triple hop for distance	8	3.6%				
	Triple crossover hop for distance	1	0.5%				
	A hop test battery (including ≥2 of the 6 m timed and single, triple hop and triple crossover hops for distance)	188	84.3%				
	Single limb vertical hop	97	43.5%				
	Star excursion and/or Y-balance test	140	62.8%				
	I do not consider these tests that important	2	0.9%				
	Other (please specify)	48	21.5%				

functional capacity (98.7%) and knee strength (87.0%), lower limb and trunk mechanics during jumping/landing tasks (96.0%), psychological readiness (87.9%) and time from surgery (78.5%) (Table 1). Of those that also selected the 'other (please specify)' option, the most common additional responses included the successful navigation of sport specific drills and training scenarios (relevant to their sport) (n = 20), as well as agility and change of direction tasks (n = 10), with hip strength (n = 3), proprioception (n = 3) and effusion (n = 3) also reported.

For evaluation of lower limb (or knee) muscular strength, a variety of methods were employed including manual muscle testing methods (33.0%), hand held dynamometry (26.7%) and isokinetic dynamometry (11.8%); with 48.9% of therapists also stating that they extrapolate or estimate strength from other measures such as hop capacity (Table 1). Of those that also selected the 'other (please specify)' option, the most common additional responses included single leg squat capacity and/or endurance (n = 10), and 1, 3 and/or 5RM measures of strength during tasks such as a single leg press, squat, single leg bridge and calf raise.

For evaluation of lower limb functional capacity, 84.3% of therapists employed a hop test battery consisting of at least two of the following tests: 6 m timed hop and the single, triple and triple crossover hop tests for distance, while 9.5% of therapists utilised only one of the aforementioned hop tests (Table 1). A single leg vertical hop (43.5%), or the star excursion balance test (SEBT) and/or Y-balance test (YBT) (62.8%) were also commonly reported (Table 1). Of those that also selected the 'other (please specify)' option, the most common additional responses included tests of agility such as the T-test or Figure 8 (n = 22), an evaluation of running dynamics and/or full pace sprinting with acceleration/deceleration tasks (n = 6), and lateral and/or medial hop tests (n = 4).

4. Discussion

This cross sectional survey disseminated to Australian Physiotherapists and AEPs, working with patients before and after ACLR, revealed differences within this group regarding current views and adopted practices with respect to rehabilitation and RTS. A range of preferred times to begin the out-patient rehabilitation process were outlined by therapists, with a similar distribution of respondents across 1–4 days, ≤7 days and 7–14 days post-surgery. Evidence-based and clinical reviews on ACLR rehabilitation often specify a range of early activities that are initiated in the first post-operative week (Adams, Logerstedt, Hunter-Giordano, Axe, & Snyder-Mackler, 2012; Wilk & Arrigo, 2017), many of which are not provided to patients prior to their hospital discharge. These exercises link with the early post-operative goals and, given the importance of early swelling control, patella mobility, quality quadriceps activation and near-normal ambulation, as well as restoring good knee range of motion (extension and flexion) (Adams et al., 2012; Wilk & Arrigo, 2017), then good rationale exists for an immediate start to the out-patient rehabilitation process within the first post-operative week. A recent multidisciplinary consensus recommended an immediate start to rehabilitation after ACLR (van Melick et al., 2016), though an optimal start time has not been proposed. At the same time, this may also be influenced by concomitant surgeries and specific surgeon guidelines (in the current study, 15% of therapists stated they would begin post-operatively once the surgeon had cleared the patient to do so), so good communication between the surgeon and therapist is essential (van Melick et al., 2016).

Variation existed amongst therapists as to the frequency of patient visitation they preferred, albeit the actual visitation frequency may depend on a range of factors including practice location and cost. It was interesting that within the first six post-operative weeks, a period in which almost 80% of therapists stated that rehabilitation was 'essential' (with a further 20% stating it as important), approximately 40% of therapists each preferred once or twice weekly visitation, with a further 12% opting for once every two weeks. Again, this is multi-factorial and typical customs of the rehabilitation practice and individual patient progression may alter these perspectives, though there is no consensus on the optimal amount of supervised sessions per week, or total sessions over the initial six week period. From 3 months post-surgery, almost 26% of therapists still preferred supervised visitation once her twice per week, with more than 40% of therapists at that stage recommending less frequent review with a patient transition toward home (or gym) based independent rehabilitation. Alternatively, while Physiotherapists and AEPs often work with patients throughout these end-stage and sport-specific conditioning phases of rehabilitation, another factor that could alter the recommended frequency of visitation is referral of the patient by an individual therapist to a personal trainer or strength and conditioning coach for late-stage rehabilitation. It is important that patients take some ownership of their own rehabilitation from this time, though periodic review and progression is still advocated (van Melick et al., 2016). Nonetheless, a systematic review in 2012 demonstrated that home-based rehabilitation with minimal therapist involvement may be effective (based on the laxity, strength and patient-reported outcome measures evaluated), particularly in a motivated patient (Kruse, Gray, & Wright, 2012).

As expected, the vast majority of therapists stated that post-operative rehabilitation was important (or essential) at different stages throughout the recovery timeline up until (and beyond) 6 months post-surgery. However, a growing body of evidence exists supporting the positive effect of pre-operative rehabilitation on post-operative outcome (Alshewaier et al., 2017; Eitzen et al., 2009, 2010; Failla et al., 2016; Grindem et al., 2015; Shaarani et al., 2013), and it was encouraging to note that the majority of therapists (95.5%) felt that pre-operative rehabilitation was important or essential. However, this survey did not proceed to investigate the percentage of patients that actually do embark on a pre-operative program prior to their surgical procedure. Some institutions recommend a progressive pre-operative rehabilitation period (of at least 5 weeks) in patients who have suffered an acute ACL tear (Grindem et al., 2015), with the rationale that improved pre-operative knee function will enhance post-operative outcome should surgery eventuate. Furthermore, recent research suggests that many patients may be successful with non-surgical treatment (Grindem, Wellsandt, Failla, Snyder-Mackler, & Risberg, 2018). However, it has been reported that Australia has the highest incidence of ACLR in the world (Zbrojkiewicz et al., 2018), and anecdotally a common mindset of Australian patients and surgeons is to proceed quickly toward surgery following injury, with many viewing their own RTS timeline as beginning from day of surgery, rather than the injury. Furthermore, the additional patient cost associated with pre-operative rehabilitation may be a deterring factor from the surgeon referring for pre-operative management.

The method employed for evaluating physical strength and/or function varied. Overall, approximately 84% of therapists employed a hop test battery consisting of at least two of 6 m timed hop and the single, triple and triple crossover hop tests for distance. These four hop measures were first published in the form of a 4-hop test battery (Noyes, Barber, & Mangine, 1991), and are reliable and easy to administer (Logerstedt et al., 2012; Noyes et al., 1991). Other commonly employed functional measures included a single leg vertical hop and/or the SEBT (or YBT). These tests are also easy to perform in a clinical setting and reduced performance in the YBT has been observed in patients after ACLR (Clagg, Paterno, Hewett, &

Schmitt, 2015), while an association between SEBT deficits and non-contact knee injuries has been reported (Stiffler et al., 2017).

Isokinetic dynamometry may be gold standard in quadriceps and hamstrings evaluation, and forms part of the current evidence-based testing batteries that have highlighted an association between side-to-side strength deficits and re-injury risk (Grindem et al., 2016; Kyritsis et al., 2016), though this was only employed by 12% of therapists likely due to cost and availability. Manual muscle testing methods (33%) and hand held dynamometry (27%) were also employed, though while it has been demonstrated that hand held dynamometry can be used to quantify quadriceps strength in a clinic setting should more specialised equipment not be available, caution must be employed as they may overestimate quadriceps strength side-to-side symmetry (Sinacore et al., 2017). Interestingly, a recent survey amongst physical therapists of the American Physical Therapy Association (APTA) reported that 56% of therapists used manual muscle testing as their only method of strength evaluation (Greenberg, Greenberg, Albaugh, Storey, & Ganley, 2018). Furthermore, the current study demonstrated that almost 50% of therapists stated that they extrapolate or estimate knee strength from other functional measures such as hop capacity. Caution must also be employed in this situation. Toole et al. demonstrated that in a cohort of young athletes cleared for sport participation after ACLR, approximately 70% of patients presented with a limb symmetry index (operated limb as a percentage of the non-operated limb) ≥90% for each of the 6 m timed hop and single, triple and triple crossover hop tests for distance (Toole et al., 2017). However, approximately 40% of patients met the ≥90% limb symmetry index for peak isokinetic quadriceps strength (Toole et al., 2017). In other recent studies, Welling et al. reported that only 3.2% and 11.3% of patients passed all criteria at 6 and 9 months post-surgery, respectively, inclusive of functional hop testing (6 months, 62.9% passed; 9 months, 77.4% passed), and peak isokinetic knee dynamometry (6 months, 8.1% passed; 9 months, 21.0% passed) (Welling et al., 2018). Furthermore, Ebert et al. showed that in ACLR patients assessed at 10–14 months post-surgery, 47–58% of patients had a limb symmetry index ≥90% for the four aforementioned hop tests, though only 31% had a peak isokinetic quadriceps strength limb symmetry index ≥90% (Ebert et al., 2017). In summary, it is clear that strength and functional tests do not necessarily align with each and should be combined in the form of a comprehensive physical test battery, while it is advisable that isokinetic dynamometry be employed if possible, and patients referred to an institution with the relevant facilities if appropriate.

Variation also existed within the permitted timing of RTS. RTS is largely criterion based (Dingenen & Gokeler, 2017), and providing all discharge criteria were met approximately 50% of therapists were willing to discharge their patients between 9 and 12 months after surgery. However, 22% of therapists were still satisfied with an earlier discharge (6–9 months). This may also depend on other factors (outside of passing all individual therapist discharge criteria) such as the professional level of the athlete and requirement to play earlier, though research has reported a reduced re-injury rate for all knee injuries if RTS is delayed until 9 months following ACLR (Grindem et al., 2016). Furthermore, 23% of therapists did not permit RTS until 12–18 months. A 24-month RTS timeline has previously been proposed (Nagelli & Hewett, 2016), taking into account the process of ligament revascularisation and maturation, the restoration of proprioceptive and neuromuscular deficits, overall knee joint health, and of course the high incidence of ACL re-injuries that have been reported (Kyritsis et al., 2016; Paterno, Rauh, Schmitt, Ford, & Hewett, 2012; Salmon, Russell, Musgrove, Pinczewski, & Refshauge, 2005; Shelbourne, Benner, & Gray, 2014). The challenge for the therapist (and surgeon) is educating the patient on the importance of rehabilitation and a delayed RTS, who is otherwise keen to return irrespective of the existing evidence.

For RTS clearance, time from surgery was still reported commonly, as was functional capacity and strength, as well as lower limb and trunk mechanics during landing tasks. When employing functional hop and muscular strength (in particular quadriceps strength) measures as part of a RTS test battery, some research has demonstrated and increased re-injury risk in patients not meeting side-to-side limb symmetry scores of ≥90% (operated versus non-operated limb) (Grindem et al., 2016; Kyritsis et al., 2016). Furthermore, research has highlighted the altered landing strategies that can present after ACLR, as well as the link between certain biomechanical deficits and ACL injury risk (Hart et al., 2016; Johnston, McClelland, & Webster, 2018; Pappas, Shiyko, Ford, Myer, & Hewett, 2016; Trigsted, Post, & Bell, 2017). Patient-reported psychological readiness was also commonly reported and, while the method of evaluating psychological readiness was not evaluated in the current study and its effect on re-injury has not been assessed, its positive association with a higher perceived functioning knee and returning to pre-injury activity levels has been reported (Ardern et al., 2014). A number of factors have also been identified that may affect psychological readiness such as gender and patient-reported symptoms and function (Webster, Nagelli, Hewett, & Feller, 2018), some of which may be modified by the therapist to assist the transition toward sport in their ACLR patients. Nevertheless, the inability of the current survey to more accurately ascertain how therapists evaluated psychological readiness was a study limitation. Overall, most therapists in the current study appeared to adopt a battery that included strength and hop measures, with a review of lower limb and trunk mechanics during functional tasks, often combined with a subjective review of psychological readiness and another functional test (i.e. SEBT and/or YBT), which is supported by current recommendations (van Melick et al., 2016).

We do acknowledge a range of further study limitations, in addition to those alluded to above. First, the nature of the survey and how it was disseminated may have created potential for response bias, with many of the following factors not accounted for and potentially contributing to variation in treatment approaches. The survey was made available exclusively to Physiotherapists and AEPs, though the distribution of respondents across these disciplines was unknown. This survey failed to specifically ask about respondent clinical experience and/or clinical practice setting, nor whether the respondent was a Physiotherapist or AEP. The latter was not included as a specific question as both of these primary allied health providers in Australia provide a similar service to ACLR patients both before and after surgery, as well as in that RTS decision making process. Furthermore, while this survey was made available specifically to Physiotherapists (via the APA) and AEPs (via ESSA) the link was open to other respondents and did not require a respondent-specific log in. While made available via APA/ESSA Member portals and State/National News Bulletins, we acknowledge that therapists from other disciplines could have been made aware of the survey link and completed the survey. Alternatively, therapists that completed the survey could have been dishonest about their primary area of expertise and/or how many ACLR patients they see annually. A greater degree of variation in rehabilitation and RTS practices may have been found if the wider physical therapy and sports training disciplines were included.

While n = 223 completed the survey, we were unable to ascertain a survey response rate given the nature of survey dissemination. While respondents were asked to answer the survey questions based on their current practice with their ACLR patients, and it was clearly stated that if therapists were not working with these patients, they should not complete the survey, we were unable to

know exactly how many of the Physiotherapists and AEPs that were made aware of the survey, were actually actively working with ACLR patients. Therefore, calculating a response rate was made impossible (i.e. what percentage of therapists actively working with ACLR patients, actually completed the survey). Furthermore, while Survey Monkey does not allow the survey to be completed on multiple occasions from the same respondent's computer and internet browser; while unlikely, we are unable to say whether individual respondents completed the same survey multiple times via accessing the same link from varied internet browsers. Some of the aforementioned issues may have been addressed through the survey requesting respondent identifying information to ensure respondent profession. While there are also benefits to anonymous surveys (with respect to honest respondent information), the anonymous nature of the survey was a requirement of not only ethics approval, but a pre-requisite of both governing bodies involved in disseminating the survey on the research team's behalf in order to target the appropriate cohort (APA for Physiotherapists and ESSA for AEPs).

The authors also assumed that the respondents that spanned all Australian states provided a good representation of the Australian therapy landscape. This survey was developed as a collaborative project with input from different disciplines (academics, Physiotherapists, AEPs and orthopaedic surgeons), though it was not validated prior to dissemination. Finally, the survey aimed to obtain an overview of the current beliefs and practices of Australian therapists in rehabilitation and RTS, though it did not proceed to seek specific information on the components of rehabilitation or specific ways certain RTS considerations were evaluated (e.g. whether psychological readiness was considered a factor that influenced RTS discharged was asked of respondents, though the method of specifically evaluating this was not explored). This is an area for future research, and there was concern amongst the survey development team that a survey overly burdensome would not be so well responded to.

5. Conclusion

The results of this survey disseminated to Australian Physiotherapists and AEPs working with ACLR patients revealed differences regarding views and practices surrounding rehabilitation and RTS (timing and evaluation methods). The value of pre- and post-operative rehabilitation is well acknowledged amongst therapists, though the initiation of post-operative rehabilitation, and frequency of supervised patient visitation through the early and later stages of recovery, is varied. Variation also exists in the timing of RTS discharge, as well as the tools employed to evaluate patients prior to RTS.

Ethical statement

Ethics approval was obtained by the University of Western Australia (RA/4/20/4328), and all participants provided content.

Declaration of interests

None (all authors).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ptsp.2018.12.004.

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