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Restrictions for Mononephric Survivors of Childhood Cancer: A Report From the Children's Oncology Group

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Abstract

Although traditional recommendations for mononephric childhood cancer survivors are to avoid contact sports in order to protect the remaining kidney, review of available evidence suggests that the majority of renal loss is caused by accidents not involving sports. An interdisciplinary team performed a review of the English literature published from 1999 to 2012 within the PubMed, Cochrane, Google Scholar, and National Guidelines Clearinghouse databases. The level of evidence and proposed recommendations were graded according to an established rubric and GRADE criteria. Our review found that kidney loss is most commonly caused by nonsports activities such as motor vehicle accidents and falls, implying that restrictions on sports-related activity in mononephric pediatric survivors are not well supported. This favors encouraging ordinary sports and related activities without restriction in mononephric childhood cancer survivors because the known benefits of exercise outweigh the exceedingly low risk of renal loss. Accordingly, activity recommendations for mononephric patients have been revised in the most current version of the Children's Oncology Group *Long-term Follow-Up Guidelines for Survivors of Childhood, Adolescent and Young Adult Cancers*. This has important implications for this and similar populations who may now undertake individual and organized sports without undue regard for their mononephric status.

Keywords

late effects of cancer; pediatric; oncology

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Declaration of Conflicting Interests

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History and Introduction

Historically, mononephric patients have been restricted from contact sports in order to preserve the remaining kidney. The current American Academy of Pediatrics (AAP) statement regarding sports participation for those with medical conditions suggests that while sports participation should be encouraged, clinical judgment is essential in considering kidney protection in mononephric patients (Rice, 2008). When our literature review was done, the then-current version of the Children's Oncology Group (COG, 2008) *Long-Term Follow-Up Guidelines for Survivors of Childhood, Adolescent and Young Adult Cancers (LTFU Guidelines, Version 3.0)* recommended that clinicians discuss the risk of certain sports with mononephric childhood cancer survivors. However, the practical value of these recommendations was limited by the need for more specificity regarding what constitutes safe activity.

Multiple publications in the urology literature suggest that traditional recommendations for mononephric patients to limit sports participation should be reevaluated since renal loss due to sports related injury is rare, and that accidents involving bicycles, all-terrain vehicles (ATVs), motor vehicles, and pedestrian injury, rather than contact sports, cause the vast majority of renal loss in children (Gerstenbluth, Spirnak, & Elder, 2002; Johnson, Christensen, Dirusso, Choudhury, & Franco, 2005; Sharp, Ross, & Kay, 2002; Wan, Corvino, Greenfield, & DiScala, 2003b; Wu & Gaines, 2007). Despite this evidence that kidney injury or loss from sports is rare, 2 physician surveys revealed that a majority of pediatric urologists restrict certain high-risk activities to protect the remaining kidney of mononephric patients (Grinsell, Showalter, Gordon, & Norwood, 2006; Sharp et al., 2002). Anecdotal evidence suggests that pediatric oncologists make similarly restrictive recommendations to mononephric childhood cancer survivors.

In response to the need for clinical practice to reflect current evidence regarding safe activity for mononephric childhood cancer survivors, our multidisciplinary team sought to define, for the first time, safe activity for this population, as part of the COG Nursing Discipline Evidence-Based Practice Initiative (Landier, Leonard, & Ruccione, 2013). Our primary goal was to develop specific, practical, and evidence-based physical activity and sports participation recommendations for this population. To accomplish this, we referred to current guidelines for mononephric childhood cancer survivors, conducted a literature review, and obtained expert pediatric urological input. As a result, the new COG *LTFU Guidelines, Version 4.0*, and associated lay language Health Link™, *Single Kidney Health After Childhood Cancer*, were revised to reflect our recommendation that encourages all activity without restriction. This report summarizes the literature review that supported the revision of the most current *COG LTFU Guidelines, Version 4.0*.

Method

After a competitive application process, our concept proposal, *Evidence-Based Kidney Activity Recommendations for Childhood Cancer Survivors*, was selected for further development by the COG Nursing Discipline. A multidisciplinary team consisting of 3 nurse practitioners, 2 nurse researchers, a pediatric oncologist, and a pediatric urologist conducted

this literature review. An evidence-based practice question, developed using the PICOT (Population, Intervention, Comparison, Outcome, Time) rubric, set out by Melnyk and Fineout-Overholt (2005), guided our literature search: “What physical activities and exercise (I and C) are safe (O) in mononephric children and adolescents (P)?” A systematic review of English literature published between 1999 and 2012 was conducted within the PubMed, Cochrane, Google Scholar, and National Guidelines Clearinghouse databases using the following search terms: *single kidney*, *kidney injury*, *kidney injury in sports*, and *kidney injury in recreational activities*. The team graded the level of evidence using the scoring rubric presented by Melnyk and Fineout-Overholt (2005), and proposed recommendations according to the GRADE criteria (Guyatt et al., 2008).

Literature Review

The literature search yielded 31 articles including 16 retrospective studies, 7 case reports, 3 literature reviews, 1 physician survey description, 1 physician survey description coupled with a literature review, 2 recommendation guideline articles, and 1 prospective study. In this section, key findings from the review are described beginning with a summary of existing guidelines, followed by findings from articles regarding kidney injury from all activities, and ending with conclusions from articles describing renal injury from specific sports. The 31 publications included in our review are summarized by category in the appendix.

Guidelines

The current AAP recommendation gives a qualified yes for participation in a host of contact, collision, and limited contact sports for mononephric patients and suggests protective equipment for the remaining kidney but without additional definitive guidance (Rice, 2008). According to the same document, clinical judgment should be exercised based on available published data, expert advice, current health status of the child, level of competition, position played, sport played, maturity of the competitor, availability of protective equipment, availability of treatment in the event of injury, ability to understand risks associated with participation, and potential danger of the sport. The then-current version of the COG *LTFU Guidelines*, Version 3.0, recommended discussing contact sports and bicycle safety with mononephric pediatric cancer survivors, since these activities were believed to result in a higher incidence of renal injuries (COG, 2008). Both the AAP and previous COG guidelines mention specific categories of sports that require caution for mononephric individuals, thereby causing providers to have a more restrictive stance regarding certain activities, but they do not offer specificity regarding how to counsel patients about safe activity and sports participation.

Kidney Injury From All Types of Trauma

Kidney injury from trauma is exceedingly rare. Retrospective database studies reveal that kidney injuries occurred in 0.05% to 1.6% of all pediatric trauma cases (McAleer, Kaplan, & LoSasso, 2002; Wan et al., 2003b; Wan, Corvino, Greenfield, & DiScala, 2003a). While 87% to 90% of Grade I to Grade III renal injuries, defined as mild contusions to cortical lacerations in the Organ Injury Scale developed by the American Association for the Surgery of Trauma, are managed with conservative, nonsurgical interventions, Grades IV and V renal

injuries, defined as laceration beyond the renal cortex, rarely require more aggressive treatment, including nephrectomy (El-Atat, Derouiche, Slama, & Chebil, 2011; Knudson & Maull, 1999; Richter & Shriver, 2001).

Kidney Injury From All Sports

According to a retrospective review of 49 651 trauma cases between 1995 and 2001 from 92 trauma centers in the National Pediatric Trauma Database, the incidence of kidney injury necessitating nephrectomy across all sport activities was 0.008% (Johnson et al., 2005). Another literature review showed that renal injury is rare in contact and collision sports (Diokno & Rowe, 2010). Whereas kidney injury is usually caused by motor vehicle accidents, falls, and bicycling, most nephrectomies are attributed to nonsports activities such as motor vehicle accidents and falls (Johnson et al., 2005; McAleer et al., 2002; Psooy, 2006, 2009; Wan et al., 2003a, 2003b; Wu & Gaines, 2007).

Kidney Injury From Contact Sports

According to 2 retrospective reviews, football causes the greatest number of sports-related renal injuries (Johnson et al., 2005; Wan et al., 2003b). However, the literature describes renal injuries resulting from football as low-grade with no reports of kidney loss and that all players with renal injuries recovered fully and returned to the sport (Brophy et al., 2008; Wan et al., 2003b; Swischukh, 2006; Waicus & Smith, 1999). Similarly, a case study revealed that a patient with a kidney injury from jujitsu only required monitoring for full recovery and another case study showed that a patient with a renal injury from wrestling needed minimal intervention (Itagaki & Knight, 2004). Our review did not identify any publications regarding kidney loss and injury as a result of other martial arts and boxing.

Kidney Injury From Snow Sports

Kidney loss is rare in snow sports, according to 3 publications. Of 10 687 injuries reported over a 9-year-period in a Japanese hospital, the incidence of kidney injury related to skiing and snowboarding was 0.18% and 0.12%, respectively (Machida et al., 1999). In an evaluation of 1142 incidents over a 5-year-period in 2 Utah medical centers, the incidence of ski- and snowboard-related renal injury was 1.22% and 1.13%, respectively (Wasden, McIntosh, Keith, & McCowan, 2009). Another study evaluated causality of blunt renal trauma in an alpine region over a 26-year-period and found that although 35% of 254 cases of Grades II to V renal traumas were ski-related, only 1.5% of those patients required nephrectomies (Radmayr, Oswald, Muller, Hörtl, & Bartsch, 2002).

Kidney Injury From Bicycling

Two large retrospective studies demonstrate that kidney injury and loss resulting from bicycling is exceedingly rare. In 1 study of 16 585 bicycle-related injuries from the Trauma Data Bank, 1.7% of all injuries involved the kidney and only 0.4% resulted in kidney loss (Bjurlin, Zhao, Goble, & Hollowell, 2011). In another study conducted between 2000 and 2005 at Children's Hospital of Pittsburgh, dirt bike and ATV rollover resulted in higher grade renal trauma when compared to renal trauma from bicycling, playing contact sports,

and riding ATVs without a rollover (Wu & Gaines, 2007). In a case study, abdominal trauma from bicycling was managed successfully with monitoring alone (Ahmed & Batiuk, 2001).

Evidence-Based Recommendation

In contrast to current AAP and previously published COG *LTFU Guidelines*, Version 3.0, our literature review supports encouraging all physical activity without restriction in mononephric childhood cancer survivors. Table 1 provides an overview of the low rate of renal injury and loss extracted from the literature review that supports this recommendation.

Recommendation

There is a strong recommendation based on low to moderate quality of evidence to encourage all activity, without restriction or qualification, in mononephric childhood cancer survivors.

Conclusion and Discussion

The current AAP Guidelines and the then-current COG *LTFU Guidelines*, Version 3.0, suggest that mononephric patients should participate in contact, collision, and limited-contact sports for mononephric patients with great caution and use of protective equipment for the remaining kidney. These recommendations, according to a survey, are likely to lead to a restrictive stance on physical activity for mononephric patients (Grinsell et al., 2006). In contrast, our literature review supports encouraging all activity, even contact sports, without restriction or kidney protection. Our recommendation is in agreement with another review that was published by Grinsell, Butz, Gurka, Gurka, and Norwood (2012) following the completion of our project.

Providing mononephric patients with ample information to make informed choices about sport participation is the role of the provider in collaborative decision making. The risk of sports-related renal loss should be presented in context—renal loss from sports participation is rare and results more often from motor vehicle accidents and falls than sports. Patient and family education should reinforce that physical activity poses little risk to the kidney and is strongly encouraged, since sports participation by children and adolescents has positive benefits in physical health, mental health, academic performance, self-esteem, and self-concept (Biddle & Asare, 2011; Dobbins, Husson, DeCorby, & LaRocca, 2013; Grinsell et al., 2012; Strong et al., 2005). Although this recommendation has significant implications for those who have required nephrectomies for management of their pediatric cancer and other populations with a single or partial kidney, it is important to respect that there are some individuals who will elect to continue avoiding certain activities after a thorough discussion of the risks and benefits of previously restricted activities. Thus, as with all patient education, documentation is an essential part of survivorship care (Psooy, 2006, 2009).

The less restrictive physical activity recommendations advocated here should be coupled with existing guidelines aimed at preserving the health of the remaining kidney including avoidance of nephrotoxic medications and careful monitoring of therapeutic levels and renal function when these medications are necessary. As a result of our literature review, the new

COG *LTFU Guidelines*, Version 4.0, and associated lay language Health Link™, *Single Kidney Health After Childhood Cancer* (COG, 2013), were revised to include updated activity recommendations after approval from the Urinary Tract Task Force and leadership of the COG Survivorship and Outcomes Committee.

Summary

Contrary to traditional recommendations to limit sports participation, this review of available published evidence points to the relative safety of all physical activities for mononephric childhood cancer survivors, since renal loss from such activities is rare. This recommendation has significant implications for this and other populations with a single or partial kidney, because it will enable these patients to participate in sports that were formerly excluded, and pursue active rather than sedentary lifestyles.

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Appendix. Literature Review Findings

Category	First Author, Year, Study Design	Subjects	Findings	GRADE Quality Level
Physician Survey	Grinsell (2006), physician survey	N = 135, mailed survey with 31% response rate	46% would allow contact sports with use of protective equipment	Low
	Sharp (2002), physician survey	N = 182, mailed surveys with 78% response rate	32.3% would allow contact sports with protective equipment, although risk of kidney injury believed to be low	Low
National Guidelines	Rice (2008), National Guideline	NA	Qualified yes for contact, collision, limited contact sports; protective equipment for remaining kidney recommended	Low
	Children's Oncology Group (2008), National Guideline	NA	Careful consideration of contact sports and bicycling	Low
Kidney injury from all types of trauma	El-Atat (2011), retrospective review	N = 180 patients hospitalized with blunt force trauma kidney injury	73% Conservative treatment adequate 2.2% Renal loss 1.6% Partial nephrectomy	Moderate
	Johnson (2005), retrospective review	N = 49 651 National Pediatric Trauma Registry 1995–2001	Kidney injury 0.02% (813); kidney injuries occur most often in MVA 36% (of all reviewed renal injuries); pedestrian vs MVA 15%; falls 13%; sports 10%	Moderate
	Knudson (1999), literature review	NA	Recommends nonoperative management of spleen, liver, kidney injuries	Low
	McAleer (2002), retrospective review	N = 14 763 patients aged 5–18 years seen for trauma	Kidney injury from trauma 1.3% (193) Kidney loss 0.006% (1 case from skiing)	Moderate
	Richter (2001), case report	N = 1	Grade V kidney injury may have been better managed with prompt nephrectomy	Low
	Wan (2003b), retrospective review	N = 81 923 National Pediatric Trauma Registry	Kidney injury from trauma 0.05% (42) No nephrectomies from kidney injury	Moderate
	Wan (2003a), retrospective review	N = 14 763 sample from trauma registry in Western New York	Kidney injury from trauma 1.3% (193) No nephrectomies from renal injury	Moderate
Kidney injury from sports	Dionoko (2010), literature review	NA	Kidney injury higher in cycling, skiing, sledding snowboarding, horseback riding than in contact sports; MVA, pedestrians vs MVA,	Low

Category	First Author, Year, Study Design	Subjects	Findings	GRADE Quality Level
			and falls are a greater cause of nephrectomy than sports	
	Gerstenbluth (2002), retrospective review	N = 68 patients with kidney injuries	Inconclusive evidence about which sports cause which level of kidney injury	Low
	Guerrero (2007), case report	N = 1	Paintball kidney injury resolved with bed rest and analgesics	Low
	Holmes (2003), retrospective review	NA	Football, rugby, hockey, soccer, horseback riding, gymnastics, boxing, snow sports most common causes of kidney injury but greatest risk is MVA	Low
	Johnson (2005), retrospective review	N = 49 651, National Pediatric Trauma Registry 1995–2001	Kidney injury from sports 1.6% (81.3); kidney loss from sports 0.014%. MVA, pedestrian vs MVA and falls cause greater numbers of renal loss	Moderate
	McAleer (2002), retrospective review	N = 14 763 patients aged 5–18 years seen for trauma	Kidney or testicular injury from sports 0.76% (113) Renal loss 0.006% (1 case from skiing)	Moderate
	Psooy (2006), literature review	NA	Head injury 5 times more likely than kidney injury in sports; MVA causes most kidney trauma; cycling, sledding, snow sports, horseback riding have higher kidney injury rates than contact sports	Low
	Psooy (2009), literature review	NA	Head injury risk is higher than kidney injury risk in contact sports; bicycling, sledding, snow sports, horseback riding have higher kidney injury risk; kidney injury is higher with MVA than in sports	Low
	Styn (2010), literature review	NA	10% of abdominal trauma cases involve kidney; contact and collision sports are more likely causes of kidney injury; kidney loss rarely occurs even at highest level of competition in most aggressive players; no report of major injury to solitary kidney	Low
	Wan (2003b), retrospective review	N = 81 923 National Pediatric Trauma Registry	Kidney injury from sports 6.6% (5439); kidney injury from sports occurred most often in football (26),	Moderate

Category	First Author, Year, Study Design	Subjects	Findings	GRADE Quality Level
Kidney injury from contact sports	Wan (2003a), retrospective review	N = 14 763 sample from Trauma Registry in Western New York	basketball (5), hockey (3), soccer (2); no renal loss Kidney injury from sports 0.66% (98); renal injury from sports occurred most often in bicycle (27), equestrian (8), motorcycle (6), skateboard (6), ATV (8), football (3), soccer (2), basketball (2); no renal kidney loss	Moderate
	Brophy (2008), retrospective review	N = 52 NFL players with kidney injuries in NFL database	Hospitalized 35% (18 total) Nephrectomy 0% Kidney injury 0%	Moderate
	Itagaki (2004), case report	N = 1, Jujitsu kidney injury	Careful monitoring was adequate	Low
	Johnson (2005), retrospective review	N = 49 651 trauma cases from 92 trauma centers	No nephrectomies from contact sport	Moderate
	Matlaga (2002), case report	N = 1	Wrestler had page kidney and required some surgical intervention for renal hematoma, but renal issues resolved with conservative treatment	Low
	McAlear (2002), retrospective review	N = 14 763 patients aged 5–18 years seen for trauma	6 kidney injuries per 1 million children engaging in contact sports No nephrectomies from contact sports	Moderate
	Patel (2005), retrospective review	NA	In light of the lack of consensus, author recommends (a) allow those with a single kidney to participate in contact sports after explanation of risks and (b) do not allow those with a low functioning single kidney to participate in contact sports	Low
	Swischukh (2006), case report	N = 1 football player	Lacerated kidney treated with close observation and conservative activity × 6 weeks	Low
	Unterharnscheidt (1995), prospective study	N = 139 professional boxers	Followed urine cast, albumin, and microscopic red blood cell finding. No definitive conclusions	Low
	Waicus (1999), case report	N = 1 football player	Grade IV renal injury (fracture) treated with close observation × 2.5 months with no complications	Moderate

Category	First Author, Year, Study Design	Subjects	Findings	GRADE Quality Level
Kidney injury from snow sports	Wan 2003b, retrospective review	N = 81 923 sample from National Pediatric Trauma Registry	Kidney injury from contact sports: football (26), basketball (5), hockey (3), soccer (2)	Moderate
	Machida (1999), retrospective review	N = 10 687 patients treated at Iiyama Red Cross Hospital from 1988–1997	Total ski injuries 9108 Total snowboard injuries 1579 Ski-related kidney injury 0.21% (19/9108) Snowboard-related kidney injury 0.82% (13/1579) No surgical procedures done	Moderate
	Radmayr (2002), retrospective review	N = 254 children referred to University Hospital of Innsbruck for kidney trauma in an alpine region	Ski injuries 36% (91 total) Nephrectomy rate 1.57% (4)	Moderate
Kidney injury from bicycling	Wasden (2009), retrospective review	N = 1142 children treated for ski/snowboard injury at University of Utah Medical Center 2001–2006 seasons	Ski-related renal injury 1.76% (14) Snowboard-related renal injury 3.74% (13)	Moderate
	Ahmed (2001), case report	N = 1 abdominal trauma from bicycling	Monitoring was sufficient; patient eventually rejected renal allograft, but was likely due to medication noncompliance more than injury	Moderate
	Bjurlin (2011), retrospective cohort study	N = 16 585 bicycle trauma cases in the National Trauma Data Bank	Kidney injuries 0.02% (276) Nephrectomy in 0.4% of kidney injuries (1)	Low
	Wu (2007), retrospective review	N = 115 kidney trauma patients @ University of Pittsburgh Hospital 2000–2005	Bicycle kidney injury 17.4% (20) Dirt bike kidney injury 5.2% (6) ATV kidney injury 11.3% (12) Contact sport injury 10.4% (12) Bicycle and ATV accidents resulted in renal injury similar to contact sports	Moderate

Abbreviations: MVA, motor vehicle accident; ATV, all-terrain vehicle; NA, not applicable.

Table 1

Percentage of Renal Injury and/or Renal Loss by Mechanism of Injury.

Mechanism	Renal Injury, %	Renal Loss	First Author, Year
All trauma	1.6 ^a	0.01% ^a	Johnson, 2005
	1.3 ^a	0.02% ^a	McAleer, 2002
	0.05 ^a	None	Wan, 2003b
	1.3 ^a	None	Wan, 2003a
All sports	0.16 ^a	0.008% ^a	Johnson, 2005
Football	Not applicable	0% ^b	Brophy, 2008
Down Hill skiing	0.18 ^c	0% ^c	Machida, 1999
	1.22 ^c	Not mentioned	Wasden, 2009
Snow boarding	0.12 ^c	0% ^c	Machida, 1999
	1.13 ^c	Not mentioned	Wasden, 2009
Bicycling	1.7 ^d	0.4% ^d	Bjurlin, 2011

^aPercentage of all trauma cases reviewed in the publication.

^bPercentage of all kidney injury cases reviewed in the publication.

^cPercentage of all ski/snowboard injury cases reviewed in the publication.

^dPercentage of all bicycle trauma cases reviewed in the publication.