Sports and the solitary kidney: how to counsel parents

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Objective: *To determine how to counsel parents of young children with a solitary kidney in a manner compliant with the recommendations of the American Academy of Pediatrics (AAP).*

Methods: *As per the AAP recommendations, the relevant information required to provide a "Qualified Yes" to involvement in contact/collision sports was obtained through a PubMed™ search and local inquiries. Questions specifically addressed were:*

- *Available published information on risks of participation*
- *Availability of effective protective equipment that is acceptable to the athlete*
- *Whether the sport can be modified to allow safer participation.*

Results: *Pediatric renal trauma can result from sporting injuries, however more renal injuries are caused by motor vehicle accidents. Those sports associated with a higher risk of significant renal injury carry a five-fold higher risk of head injury. Tolerable protective equipment is available, but whether it decreases risk of renal trauma is unknown. Participation in "high-risk" sports can be modified to allow safer participation.*

Conclusions: *Parents need to be counseled on the consequences of an injury to the solitary kidney, and potential ways to decrease such risks without being unnecessarily restrictive with respect to sports participation. Specific information to convey to parents in a concise manner is provided.*

Key Words: sports, kidney, solitary, pediatrics, counseling

Preamble

The need to counsel the parents of a young child with a solitary kidney

Physicians treating a child with a solitary kidney are expected to provide advice to parents regarding any restrictions from sports activities. The adult with a normal solitary kidney (live kidney donor) has a similar risk of end-stage renal disease (ESRD) as does the general population,[1] and thus restrictions of activity are often not given in this scenario. This raises the question of whether children with a normal solitary kidney should be treated with the same liberalism with respect to activities. However, these children are of a separate cohort from highly screened healthy adult kidney donors. Compared to adults, children have an increased risk of renal injury when exposed to blunt abdominal trauma.[2] It is also reasonable to assume that, through the school system, a child has more exposure to contact sports than does an adult. Additionally, it has been shown that as adults, those who had a pediatric "normal" solitary kidney are at increased risk of hypertension, proteinuria and renal insufficiency, showing that these kidneys are not entirely "normal" when adulthood is reached.[3] This suggests the ongoing validity of the traditional attitude that parents of a child with a solitary kidney require counseling on the risks of recreational activities.

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TABLE 1. **Classification of sports by contact**[5]

Classification	Definition	Examples
Collision	Athletes purposely hit or collide with each other or inanimate objects, including the ground, with great force	Ice hockey Tackle football Rodeo
Contact	Athletes routinely make contact with each other or inanimate objects but usually with less force than collision sports	Basketball Soccer
Limited contact	Contact with other athletes or inanimate objects is infrequent or inadvertent	Bicycling Downhill skiing
Noncontact	Contact not anticipated May be strenuous	Tennis Running Swimming

Current recommendations

The American Academy of Pediatrics (AAP) Committee on Sports Medicine and Fitness regularly publishes a statement on Medical Conditions Affecting Sports Participation. In the first publication in 1988,[4] they recommended prohibiting children with a solitary kidney from participating in contact or collision sports, but allowed participation in limited-contact sports and non-contact sports. This is defined in Table 1. In the last two publications,[5,6] the most recent being in 2001, they were more liberal with contact/collision sports and more restrictive with limited-contact sports, using the term "Qualified Yes" to approve participation in both categories. According to the definition of "Qualified Yes" provided, the child requires individual assessment and the physician must apply "clinical judgment" in making a recommendation. "Clinical judgment" is based on 11 pieces of information gathered on the particular patient and a particular sporting activity, Table 2, and thus these recommendations are not easy to follow.

Pediatric urologists have not adopted these recommendations, present since 1994. In 2002 a survey of pediatric urologists, who were active members of the AAP, reported that 68% of responders recommended patients avoid contact sports, even though 88% believed the risk of renal loss due to contact sports was < 1%, and 86% believed the risk of injury to the central nervous system was higher than the risk of renal injury.[7] The reasons for this may be multiple, including fear of liability. However, it is also much easier to say "No" than provide a "Qualified Yes".

TABLE 2. **Information useful to obtain clinical judgment**[6]

	AAP 2001: Clinical judgment involves:
1*	Available published information on the risks of participation
2	The advice of knowledgeable experts
3	The current health status of the athlete
4	The level of competition
5	The position played
6	The sport in which the athlete participates
7	The maturity of the competitor
8*	The availability of effective protective equipment that is acceptable to the athlete
9	Whether treatment (e.g. rehabilitation of an injury) has been complete
10*	Whether the sport can be modified to allow safer participation
11	The ability of the athlete and parents to understand and accept risks involved in participation

*Felt by author to be relevant to the sports naïve child

Applying the AAP recommendations to the sports naïve child

If one were to try to follow the AAP recommendations, a number of suggestions are listed on how to obtain this "clinical judgment", but most refer to gathering information about a specific position of a specific sport with a specific level of competition, Table 2. This is relevant to the individual family who seeks advice on whether their child should, for example, continue to play quarterback on his high school football team, but is not relevant to the counseling of parents of a young child, who is yet sports naïve, and may never be seen again in a urologist's office. Of the 11 suggestions listed by the AAP for obtaining "clinical judgment", the author felt three were relevant to the sports-naïve child. These are listed and individually addressed below.

- Available published information on risks of participation
- Availability of effective protective equipment that is acceptable to the athlete
- Whether the sport can be modified to allow safer participation

Methods

Available published information on risks of participation

Information from the US Renal Data system was obtained to try to determine if any solitary kidneys were lost to sports in children. Using PubMed™, a review of the literature on pediatric renal trauma was carried out using the key words "pediatric renal trauma" and "kidney", "trauma" and "sports" with the limit of ages 0-18 years. "Related articles" of all representative articles were screened. Articles that did not sufficiently detail the etiology of the renal trauma were excluded, as were papers obviously reporting overlapping data from a specific registry. Only North American articles published from 2000-2005 were selected for in-depth review, as these were felt to most accurately reflect the recreational activities of today's North American child. Where able, each study was analyzed to determine the number of injuries that were sports-related, and which were related to both passenger and pedestrian motor vehicle accidents (MVAs), including motorcycle accidents. Bicycle MVAs were considered sports-related. Activities involving recreational motorized vehicles, such as all-terrain vehicles (ATVs) and jet skis, are not considered "sports" by the AAP. However, as they were frequently listed as an etiology for pediatric renal trauma, the author felt it worthwhile to include these recreational activities in the review, but not consider them as "sports". For sports associated with high-grade renal injuries, a PubMed™ search was performed to find articles that compared the rate of renal injuries versus head injuries for that particular sport.

Availability of effective protective equipment that is acceptable to the athlete

Information was obtained by contacting both a national chain and local sporting goods store.

Whether the sport can be modified to allow safer participation

This question was posed for the five sports found most likely to cause high-grade renal trauma. Using PubMed™, articles that discussed these sports and how to make them safer, were reviewed. Whenever possible, information specific to reducing renal injury was obtained.

Results and discussion

Available published information on risks of participation

As of 2002, loss of a solitary kidney due to sports had never been documented[7] and none were identified during this literature review. Although this is likely under reported, it is reassuring that in this not-so-rare condition, with an incidence of 1/1200 births, none have been reported, especially when one considers that many of these children lived unrestricted lives prior to the advent of antenatal ultrasound. Recent information from the US Renal Data system was obtained. During the 5-year period of 1998-2002, 12 people under the age of 20 were newly diagnosed with ESRD secondary to "Traumatic or Surgical Loss" of a kidney[8*]. These data do not further delineate if any of these were from recreational activities.

The literature is not clear on which recreational activities put the kidney at the highest risk of injury. Although it would be ideal to compare the various sports based on risk of renal injury (number renal injuries/child participating or number renal injuries/hour of participation), the data is not available to allow such comparisons. Instead, data are reported as the relative risk of a renal trauma being secondary to a specific sport, or risk of a specific sport's injury being renal. The interpretation of these data can be biased if one does not know the number of children who participate or the hours spent participating in each sport, or the risk of being injured at all by a specific sport. For example, based on one pediatric emergency room's experience, 12% of renal injuries were from

bicycles and 2% were from sledding injuries,[9] making bicycling look more dangerous to the kidney. In contrast, if one were to be injured on a bicycle, the chance of it being a renal injury is 1.4%;[10] however, if injured while on a sled, the risk of injury being renal is 8%.[11] Which of these two activities is more dangerous to the solitary kidney?

The literature search identified seven articles[9,12-17] presenting pediatric renal injuries of all grades and two articles presenting only high-grade renal injuries,[18,19] Table 3. Of the six studies reporting renal injuries of all etiologies and all grades,[9,12-16] none cited sports activities as causing more renal injuries than MVAs. A weighted mean of the results of these studies shows that MVAs were responsible for 57% of pediatric renal trauma while sports were responsible for 21%. The two relatively small studies of exclusively high-grade renal injuries show sports to be the dominant etiology, with a weighted mean of 28.1% versus 18.8%. Although none of the other articles delineate the etiology of high grade renal injuries into MVA versus sport, the largest study by Johnson et al[14] reports sports-related injuries resulted in nephrectomy in 2.2% versus 3.9% of MVA related renal traumas. However, it is inappropriate to draw conclusions from these data, as horse-related injuries, which resulted in three nephrectomies, were not considered as "sports", and renal trauma grading was not reported in the children who died with, but not necessarily from, renal injuries (7.7% of MVAs and 3.9% of sports injuries). Therefore, the overall risk of renal injury from sports activities appears to be less than the risk of renal injury from an MVA, but it remains unclear if a high-grade injury is more likely to be caused by an MVA.

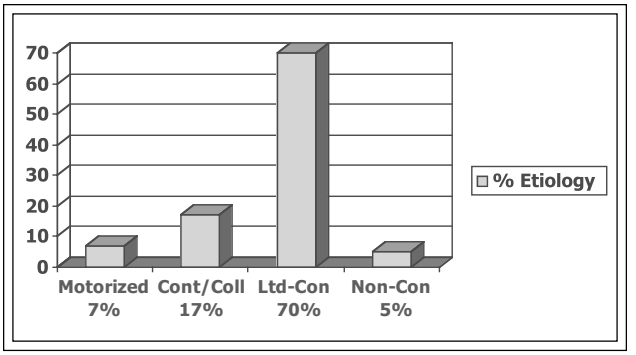

Figure 1. Breakdown of all reported renal trauma caused by recreational activities9,12,14-16 into motorized sports and the AAP categories of contact/collision (Cont/Coll), limited-contact (Ltd-Con) and non-contact (Non-Con) sports. These are presented as weighted means.

Efforts were made to determine if the AAP's revised recommendations to fully approve "non-contact" sports, but limit approval of "contact/collision" and "limited-contact" sports with a "Qualified Yes" were appropriate. Limited by the details provided within the selected articles, whenever possible, responsible recreational activities were categorized into one of the three risk classifications described by the AAP[6] or the classification of motorized recreational activities. Supporting the recommendations of the AAP, the majority of injuries sufficiently detailed were secondary to "limited-contact" sports, whereas "non-contact" sports contributed minimally, Figure 1. Motorized recreational activities also contributed minimally, although the relative exposure to motorized recreational vehicles may be much lower than that of

TABLE 3. **North American pediatric renal trauma data**

Reference	State	Years of data	# Renal injuries	Grade of injury
Buckley et al[12]	CA	25	333	I-V
Nance et al[13]	PA	7	95	I-V
Johnson et al[14]	Multi (NPTR*)	6	813	I-V
McAleer et al[15]	CA	16	193	I-V
Margenthaler et al[16]	MO	14	55	I-V
Gerstenbluth et al[9]	OH	6	68	I-V
Wan et al[17]	NY	7	16	I-V
Russell et al[18]	OH	11	15	IV
Rogers et al[19]	MD	12	20	IV-V

*National Pediatric Trauma Registry

TABLE 4. **Etiology of high grade injuries**

Activity	No. of high grade injuries	Contact classification
Bicycling	10	Limited
Sledding	5	Contact/collision
Alpine skiing	4	Limited
Snowboarding	3	Limited
Equestrian	3	Limited
Hockey	2	Contact/collision
Football-tackle	2	Contact/collision
Skateboarding	2	Limited
In-line skating	1	Limited
Football-flag	1	Limited
Basketball	1	Contact/collision
Baseball	1	Limited
ATV	1	Motorized

non-motorized recreational activities.

As "team" sports are often implicated as high-risk activities to avoid, further analysis of the selected articles was performed to see if team sports deserved such notoriety. Based on the five articles that allowed such breakdown,[9,14-17] team sports were the cause of sports-related renal trauma in only 20% (weighted mean). Therefore, avoidance of team sports in general does not seem indicated.

Are there any particular sporting activities that are more dangerous than others? Only high-grade renal injuries are associated with significant loss of function.[20] Limited by the details provided within the selected articles, whenever possible, high-grade renal injuries were sub-classified to the specific responsible recreational activity. Thirty-six injuries from six papers[9,14,15,17-19] allowed such sub-classification. Bicycling, sledding, skiing, snowboarding and equestrian activities were each responsible for three or more high-grade injuries, Table 4. Review of the literature, done to determine if these particular activities should be labeled "high-risk" for children with solitary kidneys, shows that based on the data available, all of these "high-risk" activities have a relative risk (R.R) of a head injury that is at least five times that of a renal injury, Table 5. Therefore, although these activities may have a higher risk of injuring a "solitary kidney", they all seem to carry a much higher risk of injury to the "solitary brain."

Availability of effective protective equipment that is acceptable to the athlete

Equipment designed to provide added protection to solitary orthotopic kidneys is available in the form of rib protectors and blocking vests. However, they are not easily accessible if one is not given some direction on where to look and what they are called. A manager of a large, national chain sporting-goods store was contacted and asked about any available "protective padding for the kidneys"; he was unaware of any. It was only following the advice of the local pediatric nephrology service, that the author was able to find a sporting goods store selling such equipment. The sales person felt that this equipment was well tolerated (Diamond Athletics, Winnipeg, Manitoba), and available in children's sizes at prices between $45 – $65 CAD. An on-line search using "blocking vests" shows that this equipment is readily available if one knows what to call it. Sports and physiotherapists can also design custom-made protection. Finally, kidney belts, designed for motorized sporting activities, are available, and may provide added protection. However, the author was unable to find any data on the effectiveness of any of this equipment.

Whether the sport can be modified to allow safer participation

This question was posed for the five activities most

TABLE 5. **Relative risk (R.R.) of "high-risk" sports**

Sport	% of injuries to head	% of injuries to kidney	R.R. of head: renal injury
Bicycling[10]	47	1.4	34
Sledding[11]	44 (excluding concussion = 28)	8	5.5
Skiing[21]	71	13	9.5
Snowboarding[22]	44	7.4	5.5
Equestrian[23]	24	2.5	5.9

responsible for causing high-grade renal injuries.

Bicycling: Most serious non-MVA injuries are related to handlebars. When a child loses control of the bike and begins to fall, the front wheel rotates in a plane perpendicular to the body. The child's trunk then lands on the end of the handlebar, which acts as a blunted spear. Ensuring the bicycle is appropriately matched to the child's size and skill level, and ensuring that the bike is properly maintained can lower the risk of losing control of the bike. Handlebars can be made less dangerous by ensuring the bars do not wear through the padding provided, adding additional padding, or selecting handlebars that curve away from the rider.[24] Additionally, as stated earlier, the risk of injury from MVA is higher than that from recreational activities, and thus the teaching of road safety to avoid a collision with a motor vehicle would be prudent.

Sledding: Sledding can be made safer by limiting this activity to designated sledding hills (which should be clear of roadways and stationary objects such as poles and trees). Crowded hills should be avoided and adult supervision is ideal. Sleds with steering mechanisms are felt to be safer than those without, and the sled should not be towed behind a motorized vehicle.[11]

Alpine skiing/snowboarding: Machida et al[25] found that snowboarders are much more likely to injure kidneys compared to skiers, likely because skiers fall forward and snowboarders fall backwards. This suggests that the child with the solitary kidney may be safer on the slopes with skis rather than on a snowboard. Snowboard injuries are most likely to occur in beginners, so lessons are suggested.[26] In young skiers, overall risk of injury is associated with low skill, rented equipment (instead of owned) and ill-adjusted bindings. While skill can be improved with lessons and experience, it is important that parents realize that improper ski equipment can increase risk of injury.[27]

Equestrian activities: Equestrian injuries may be decreased by parental supervision when a child is on or near a horse. Riding activities and horses should be matched to the child's capabilities. Children should be taught to avoid standing directly in front and in back of a horse, where a hoof kick is most likely to land.[28]

Conclusions:

There is a need for pediatric urologists to be able to counsel the parents of young children with solitary kidneys with respect to sports participation. The current AAP recommendations can still be applied in this situation. As per the AAP recommendations, the "Clinical Judgment" required to determine how to counsel such parents was obtained by answering the three questions in the discussion above. Based on this, the following information should be conveyed to the parent of a child with a solitary kidney:

How to counsel the parents of young children with a solitary kidney

1. Your child has only one kidney
2. If your child should lose their kidney for any reason, they will require dialysis or a kidney transplant
3. If your child injures their kidney for any reason, they likely increase their future risk/degree of renal insufficiency
4. Renal injury can result from contact/collision or limited-contact sports, but the risks are less than the risk of an injury to the head
5. Keep things in perspective: If your child having only one brain does not stop you from letting him or her do an activity, then do not let the fact that he or she has only one kidney
6. Risk of renal injury might be decreased by wearing protective padding during contact/collision and limited-contact sports
7. We do not know the exact risk of renal injury for each sport, but according to available studies, bicycling, sledding, alpine skiing and snowboarding and horse-related activities may carry a higher risk than other activities

a. Bicycling is a common activity that can be made safer for your child by proper maintenance of the bicycle and handlebars

b. Care should be taken to ensure that sledding and horse-related activities are done in a safe manner, ideally with supervision

c. Alpine skiing may be safer than snowboarding. Lessons for the beginner are encouraged, especially for snowboarding. Good quality, properly fitted equipment decreases risk of injury when alpine skiing

8. Renal injuries from motor vehicle accidents are much more common than injuries from sports activities, therefore always have your child in appropriate car restraints and teach pedestrian and bicycle road safety □

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