Research design & study execution workshop series

Session 3

AUGUST 26, 2015

Montage team sports challenge: Part II

How can Montage help us ask and answer different types of research questions using existing data?

Sample topic: Sports-related injuries

Quick review

Sessions 1 & 2

Research questions

- FINER, ‘predictor & outcome’ format

Overview of study designs

- Case report, case series, cross-sectional study, cohort study, case-control study

Choosing appropriate study subjects

- Populations vs. samples; inclusion/exclusion criteria; developing a sampling plan

Getting started with Montage

- Team sports challenge

Background readings

What makes a good research question?

Chapter 1. Getting started: The Anatomy and Physiology of Clinical Research

Chapter 2. Conceiving the research question and developing the study plan

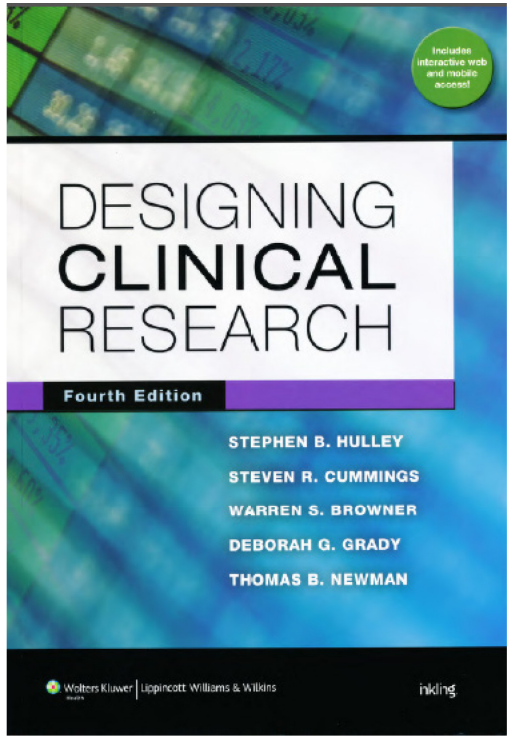
Choosing appropriate study subjects

Chapter 3. Choosing the study subjects: Specification, sampling and recruitment

Study designs

Chapter 7. Designing cross-sectional and cohort studies

Chapter 8. Designing case-control studies



Some sticking points…

Need help clarifying your research question? Ask yourself…

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Need help clarifying your research question? Ask yourself…

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- Am I trying to replicate or refute those findings?
- In the same (or a different) study population?
- Under the same (or different) clinical circumstances?
- Using the same (or different) measurement techniques?
- What were the key limitations of the previous studies?

Then, write down the answers to help clarify your thinking

Lack of clarity is costly.

- It creates confusion
- It wastes time & effort

It may prevent you from…

- Finding good collaborators
- Getting your ideas funded
- Obtaining IRB approval
- Collecting the type of data you really need to answer your question

- Or – getting your study published in the end

Does your explanation pass “the grandmother test”?

If so, congratulations!

Montage team sports challenge: Part II

Which sport resulted in the highest total number of different **exams** and **patients** with a sports-related injury over the past 15 years?

	Exams	Patients
A. Baseball		
B. Basketball		
C. Football		
D. Hockey		
E. Soccer		

Which sport resulted in the highest total number of different **exams** and **patients** with a sports-related injury over the past 15 years?

	Exams	Patients
A. Baseball	267	209
B. Basketball	3046	2471
C. Football	**4766**	**3350**
D. Hockey	117	83
E. Soccer	946	751

Key definitions and assumptions

- Any exam with the word “[name of sport*]" appearing in the report text field represents a patient with a sports-related injury

* baseball, basketball, hockey, soccer, football

Thoughts about this assumption?

One possible research question

Has the total number or nature of exams associated with football-related injuries changed over the past 15 years?

Study design: Time-series analysis

Title of study	Trends in football-related injuries investigated at a tertiary care children's hospital: 2000-2014
Research question	Has the total number or nature of exams associated with football-related injuries changed over the past 15 years?
Significance	Increased public awareness about the long-term impact of concussions, rules of football have changed, etc.
Study design	Time-series analysis
Subjects	Exams on 6-17 year old males (Jan 1, 1990-Dec 31, 2014) who reported playing football prior to the injury being investigated
Predictor variable(s)	Time period, age group
Outcome variable	Number and type of radiology procedures (defined by the modality and anatomical location of the injury)
Primary null hypothesis	No change in the overall number or type of exams associated with football-related injuries

Key variables available in Montage

Exam-related factors

Accession number (anonymized)

Exam code

Organization (CH, CNI, SG, etc.)

Exam completed (date/time stamp)

Report text (context)

Patient-specific factors

MRN (anonymized)

Patient age

Patient sex

Patient status (Emergency, Inpatient, Outpatient)

Derived variables

Year: extracted from date exam completed (2000 to 2014)

5-year period: recoded from year (2000-2004, 2005-2009, 2010-2014)

Age group: recoded from patient age (6-8, 9-11, 12-14, 15-17 yrs)

Anatomical-site of injury: recoded into groups based on exam code

Challenges and questions:

Selection criteria

What age range?

Only include patients who come to the ER or outpatients/inpatients?

Only new injuries, old injuries, all injuries?

Outcome measurement

How can/should injuries be identified and classified?

15-years of football-related data (2000-2014)

Inclusion criteria	n	Notes	Feature
All exams completed between Jan 1, 2000-Dec 31, 2014 that had "football" mentioned anywhere in the report text	4766	Date based on the "Exam Completed Date" variable from Montage	Temporal & clinical
Include all exams done at Children's (in DC)	4646	Few exams done elsewhere (n=120) (geographic)	Geographic
Include all males	4448	Few females (n=158)	Demographic
Include all 6-17 year olds	4335	Few older or younger patients (n=168)	Demographic

* Total number excluded = 446 (9%)

15-years of football-related data (2000-2014)

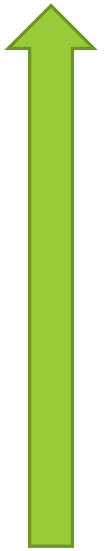
Exclusion criteria	n	Rationale
Starting pool of exams (6-17 yr old males); 2000-2014	4335	
Any patients with a mention of “football sign” in the text		Probably not a football injury
Patient status (ER, Inpatient, Outpatient)		Most patients records do not include this information so it can not be used
Follow-up visits for an existing injury		Need to do eliminate all follow-up visits if we are interested in the incidence of new injuries

To be continued…

Other possible study designs for football injuries

- Case report
- Case-series
- Cross-sectional study
- Cohort study
- Case-control study

Predictor [exposure]	**Outcome**
Radiological finding	Clinical status of patient [has a disease, needs surgery, etc.]
Characteristic of the patient [age, sex, race, clinical history, etc.]	Radiological finding



Study enrollment happens in the present

All patient data collected in the past

Case report: Key features

- Describes the aspects of a single case in order to highlight unique and/or unusual findings

Sampling strategy

Chose an excellent example of a “typical” or “atypical” case

Case report

Sports Health. 2015 Jul;7(4):318-25. doi: 10.1177/1941738113502153.

A Case of Posterior Sternoclavicular Dislocation in a Professional American Football Player.

Yang JS[1], Bogunovic L[1], Brophy RH[1], Wright RW[1], Scott R[2], Matava M[1].

Author information

Abstract

Sternoclavicular (SC) dislocation is a rare injury of the upper extremity. Treatment of posterior SC dislocation ranges from conservative (closed reduction) to operative (open reduction with or without surgical reconstruction of the SC joint). To date, we are unaware of any literature that exists pertaining to this injury or its treatment in elite athletes. The purpose of this case report is to describe a posterior SC joint dislocation in a professional American football player and to illustrate the issues associated with its diagnosis and treatment and the athlete's return to sports. To our knowledge, this case is the first reported in a professional athlete. He was treated successfully with closed reduction and returned to play within 5 weeks of injury.

KEYWORDS: American football; National Football League; closed reduction; rehabilitation; sternoclavicular dislocation

PMID: 26137177 [PubMed] PMCID: PMC4481669 [Available on 2016-07-01]

Case report

How to identify a good candidate?

- Use Montage to create an Excel data set (broad inclusion criteria)
- Search through the Report text field for any mention of an unusual radiological finding or injury in a specific age group of patients seen in different settings, using a specific modality, or type of exam
- First do a visual search to identify specific phrases, then automate the process using a search feature in Excel or Stata

Case report

Clinical History: 14-year-old male status post football injury to the anterior chest with **sternoclavicular dislocation**.
Exam: CT, thorax, with contrast
Year: 2004
Impression: Bilateral dislocated sternoclavicular joints as described.

Case report

1. Based on age and patient status

RECODE of rawage (Patient Age)	Patient Status			
	Emergency	Inpatient	Outpati..	Total
6-8 yr	215	56	8	5	284
9-11 yr	765	133	34	5	937
12-14 yr	1,605	262	84	13	1,964
15-17 yr	920	164	62	4	1,150
Total	3,505	615	188	27	4,335

Case report

2. Based on age and modality

Modality	RECODE of rawage (Patient Age) 6-8 yr ol	9-11 yr o	12-14 yr	15-17 yr	Total
	1	9	19	5	34
CR	263	874	1,790	1,066	3,993
CT	15	38	117	39	209
DX	0	1	1	0	2
MR	5	6	15	23	49
NM	0	0	1	2	3
RF	0	1	2	3	6
US	0	7	12	10	29
XA	0	1	7	2	10
Total	284	937	1,964	1,150	4,335

Case report

3. Based on age and exam type

114 different exam codes
- 30 = 90% of exam volume
- 84 = 10% of exam volume

Exam Description	Freq.	Percent	Cum.
65. XR, ankle; complete, minimum of thr	400	9.23	9.23
79. XR, hand; minimum of three views	388	8.95	18.18
87. XR, knee; three views	343	7.91	26.09
100. XR, shoulder; complete, minimum of	342	7.89	33.98
59. XR Finger 2 Views	285	6.57	40.55
111. XR, wrist; complete, minimum of th	275	6.34	46.90
77. XR, forearm, two views	229	5.28	52.18
75. XR, foot; complete, minimum of thre	162	3.74	55.92
70. XR, elbow; complete, minimum of thr	137	3.16	59.08
108. XR, tibia and fibula, two views 2y	130	3.00	62.08
69. XR, clavicle, complete	125	2.88	64.96
102. XR, spine, cervical; two or three	117	2.70	67.66
8. CT BRAIN W/O CONTRAST	100	2.31	69.97
[illegible] ankle; two views	86	1.98	71.95
80. XR, hand; two views	81	1.87	73.82
67. XR, chest, two views	70	1.61	75.43
83. XR, humerus, minimum of two views	70	1.61	77.05
85. XR, knee; complete, four or more vi	68	1.57	78.62
81. XR, hips, bilateral, minimum of two	64	1.48	80.09
106. XR, spine; thoracic, two views	59	1.36	81.45
86. XR, knee; one or two views	58	1.34	82.79
74. XR, femur, two views	57	1.31	84.11
104. XR, spine, lumbosacral; two or thr	39	0.90	85.01
112. XR, wrist; two views	39	0.90	85.91
44. TRAUMA SERIES	37	0.85	86.76
58. XR C-SPINE 1 VIEW	32	0.74	87.50
71. XR, elbow; two views	32	0.74	88.24
9. CT C-SPINE W/O	30	0.69	88.93
76. XR, foot; two views	30	0.69	89.62
18. FINGER 2 V MIN	29	0.67	90.29

Case report

CT of the brain without contrast

RECODE of rawage (Patient Age)	RECODE of year (year)			Total
	2000-2004	2005-2009	2010-2014	
6-8 yr old	3	2	4	9
9-11 yr old	5	10	4	19
12-14 yr old	9	26	20	55
15-17 yr old	4	7	6	17
Total	21	45	34	100

Case series: Key features

- Includes multiple individuals with a specific outcome
  A radiological finding, specific disease, or disease-related outcome

Sampling strategy is based on the outcome

A. Include patients with the specific outcome of interest

B. Include patients with the specific outcome **AND** a specific exposure or patient characteristic in order to describe and highlight unusual combinations

Case series: Example 1

Abstract ▾ Send to: ▾

Medicine (Baltimore). 2015 Feb;94(7):e562. doi: 10.1097/MD.0000000000000562.

Anterior inferior iliac spine avulsion fracture: a series of 5 cases.

Serbest S[1], Tosun HB, Tiftikçi U, Oktas B, Kesgin E.

⊕ **Author information**

Abstract

Avulsion fractures of the pelvic apophyses rarely occur in adolescent athletes in the course of sudden strong contraction of muscle attached to growth cartilage. This injury may usually be misdiagnosed for tendon or muscle strain. Patient's history, physical examination, and radiologic studies are important for diagnosis. The literature includes only a few case reports but no case series as yet. The aim of this study was to present the results of 5 cases of anterior inferior iliac spine (AIIS) avulsion fractures treated conservatively. The study included 5 patients (4 male, 1 female, mean age 13.6 years) who underwent conservative treatment for AIIS avulsion fractures and had an adequate follow-up. All patients were admitted to the emergency department and misdiagnosed as muscle strain. Three of them were football player, 1 skier, and 1 fighter. Each patient was treated with immobilization and nonsteroidal anti-inflammatory drugs. At follow-up, all patients showed relief from their pain and mechanical symptoms and regained full range of motion and returned to their previous levels of activity. Diagnosis requires careful attention to the physical examination and imaging. In this series, all pelvic avulsion fractures (100%) were managed successfully with a conservative approach. Good results and return to previous levels of activity can be achieved with conservative treatment.

PMID: 25700329 [PubMed - indexed for MEDLINE]

Case series: Example 2

Med Sci Sports Exerc. 2013 Oct;45(10):1971-4. doi: 10.1249/MSS.0b013e318294b4ed.

Athletic participation in children with symptomatic spondylolysis in the New York area.

Ladenhauf HN[1], Fabricant PD, Grossman E, Widmann RF, Green DW.

Author information

Abstract

PURPOSE: The purpose of this study was to assess athletic activities associated with spondylolysis in children and adolescents in a New York metropolitan tertiary referral center.

METHODS: We retrospectively evaluated 137 consecutive cases of symptomatic spondylolysis presenting to one of two pediatric orthopedic spine surgeons. Ten patients who did not participate in any organized athletics were excluded, leaving 127 children for analysis. Data regarding spondylolysis and athletic participation were gathered for analysis.

RESULTS: One hundred and twenty-seven patients were analyzed (mean age, 13.9 ± 2.2 yr). All patients had initial x-rays, with nearly all obtaining further advanced level imaging to confirm the diagnosis of spondylolysis. Magnetic resonance imaging was obtained in 42.5% of cases, limited computed tomography scan in 29.1% of cases, and single-photon emission computed tomography scan in 23.6% of cases. The most common location of spondylolysis was at the L5 level (74%), of which 43.6% were bilateral. Of the overall cohort, 2.4% had spondylolysis at multiple levels. The most common athletic activities associated with spondylolysis in this cohort were soccer (19.3%), basketball (17.2%), and lacrosse (9.4%).

CONCLUSION: Although previous reports have implicated participation in various sports in the development of symptomatic spondylolysis in children, lacrosse and baseball have rarely been associated with spondylolysis. We found that in the New York metropolitan area, soccer, basketball, lacrosse, baseball, tennis, and football were most commonly associated with spondylolysis. Therefore, we emphasize consideration of spondylolysis in these children if they present with low back pain. These results may be used to counsel parents and young athletes about the possibility of spondylolysis as an etiology of lumbar back pain and in educating coaches, teachers, school nurses, and primary care providers.

Case series

How to identify a good set of candidates?

- Repeat process described for case report finding

- Identify a large enough group to accomplish your goal
- Record all inclusion/exclusion criteria in order to document and replicate the findings

Case series

Investigate all exams “CT of the brain without contrast” among 6-8 year olds

RECODE of rawage (Patient Age)	RECODE of year (year) 2000-2004	2005-2009	2010-2014	Total
6-8 yr old	3	2	4	9
9-11 yr old	5	10	4	19
12-14 yr old	9	26	20	55
15-17 yr old	4	7	6	17
Total	21	45	34	100

Case 1 History: 8-yr old; Patient playing football, tackled behind, positive loss of consciousness and vomiting. Impression: Normal CT.

Case 2 Clinical History: 7-year-old playing football, tripped, landed on head with apparent 10 minute loss of consciousness. Appears well. Impression: Normal brain.

Case 3 History: 7-yr old; Football head to head collision. Impression: Right frontal scalp hematoma and laceration.

Case 4 History: 8-yr old; Headache, vomiting for 1 week after football injury. Impression: Mild-to-moderate ventriculomegaly involving the lateral and third ventricles with evidence of previous right hemispheric infarct.

Cohort study: Key features

- Includes multiple individuals based on their “exposure” pattern;
  General characteristics (age or sex); risk factors (smoking); an intervention; or a disease
- All must be initially free of the “outcome”
- All must be followed over time to assess the occurrence of the “outcome”
  A radiological finding; specific disease; or disease-related outcome

Sampling strategy is based on exposure

A. All exposed persons
B. All unexposed persons
C. Both

Cohort study

Am J Sports Med. 2013 Sep;41(9):2059-64. doi: 10.1177/0363546513495173. Epub 2013 Jul 10.

Risk factors for lumbar disc degeneration in high school American football players: a prospective 2-year follow-up study.

Nagashima M[1], Abe H, Amaya K, Matsumoto H, Yanaihara H, Nishiwaki Y, Toyama Y, Matsumoto M.

Author information

Abstract

BACKGROUND: Several risk factors have been proposed for intervertebral disc degeneration (DD) among adolescent athletes. However, the causes of DD are not well understood, and there have been few prospective studies evaluating DD in adolescents.

PURPOSE: To identify risk factors for DD among adolescent American football (AF) players.

STUDY DESIGN: Cohort study (prevalence); Level of evidence, 2.

METHODS: This study investigated the relationships between the progression of DD and the following factors: lumbar spine abnormalities on baseline radiographs, body mass index, AF position played (lineman or other), and length of playing career (2 full competitive AF seasons or <2 seasons). Included were 192 students who joined a top-ranked high school AF team from 2004 to 2008. Of these, 160 played for 2 full competitive AF seasons. The remaining 32 players, who stopped before completing 2 seasons, were used as a control group. Baseline radiographs and lumbar magnetic resonance imaging (MRI) scans were obtained when the players enrolled in the AF team in May, and follow-up lumbar MRI scans were obtained 2 years later at the end of their second academic year in March. Disc degeneration was measured by the signal intensity of the nucleus pulposus, and its progression was evaluated by multiple regression analysis of decreases in signal intensity. Also analyzed was the relationship between DD and low back pain (LBP).

RESULTS: The mean decrease in signal intensity of the nucleus pulposus was 4.30% ± 11.63% in players who completed 2 AF seasons and 1.41% ± 10.03% in those who did not (P = .12). Mean visual analog scale scores for LBP at follow-up were significantly higher (P = .001) in players who had played for 2 full seasons (2.67 ± 2.81) than in those with a shorter career (0.99 ± 1.61). Decreases in signal intensity of the nucleus pulposus after 2 years of playing AF related significantly to playing a lineman position (partial regression coefficient, 3.47%), the presence of Schmorl nodes (partial regression coefficient, 3.58%), and disc herniation (partial regression coefficient, 4.09%).

CONCLUSION: Significant risk factors for DD progression in high school AF players included playing a lineman position, the presence of Schmorl nodes, and disc herniation. Continuing to play AF through 2 years of high school was a risk factor for the onset of LBP.

Cohort study

How to identify a suitable cohort?

- Clearly define your “exposure”
- Use Montage to create an Excel data set (broad inclusion criteria)
- Chose individuals based on modality, exam type, age, time period
- Search through the Report text field to classify individuals in/out

- Also need a clearly defined ‘outcome’ that can be assessed from existing patient records

Cohort study: Example 1

Risk factors [exposure] for disease progression/healing process [outcome] among football-players who followed over a specified period of time

Predictor/exposure:
Patient's age, type of injury, severity of injury, etc. during initial investigation

Outcome:
Status of disease/healing process at follow-up [at a defined time period later]

Cohort study: Example 2

Incidence of and risk factors for radiology procedure-related infections in population A

Predictor/exposure
Patient's age, sex, type of procedure, known complications during procedure, underlying health status, etc.

Outcome
Acquisition of a specific type(s) of infection during a specified time frame

Cross-sectional study: Key features

- One measurement time point
- Compare the frequency of the “exposure” and “outcome”

	Has outcome	Does not have outcome
Exposed		
Not exposed		

Sampling strategy is based on examining an accessible population known/presumed to have variations in either the “predictor/exposure” and/or “outcomes”

Cross-sectional study:
Example 1

J Neurotrauma. 2015 Jul 22. [Epub ahead of print]

Age at First Exposure to Football is Associated with Altered Corpus Callosum White Matter Microstructure in Former Professional Football Players.

Stamm JM[1], Koerte IK[2], Muehlmann M[3], Pasternak O[4,5], Bourlas AP[6], Baugh CM[7], Giwerc MY[8], Zhu A[9], Coleman MJ[10], Fritts NG[11], Martin B[12], Chaisson C[13], McClean MD[14], Lin AP[15], Cantu RC[16,17], Tripodis Y[18], Stern R[19], Shenton ME[20].

Author information

Abstract

Youth football players may incur hundreds of repetitive head impacts (RHI) in one season. Our recent research suggests that exposure to RHI during a critical neurodevelopmental period prior to age 12 may lead to greater later-life mood, behavioral, and cognitive impairments. Here we examine the relationship between age of first exposure (AFE) to RHI through tackle football and later-life corpus callosum (CC) microstructure using magnetic resonance diffusion tensor imaging (DTI). Forty retired National Football League (NFL) players, ages 40-65, were matched by age and divided into two groups based on their AFE to tackle football: before age 12 or at age 12 or older. Participants underwent DTI on a 3 Tesla Siemens (TIM-Verio) magnet. The whole CC and five subregions were defined and seeded using deterministic tractography. Dependent measures were fractional anisotropy (FA), trace, axial diffusivity and radial diffusivity. Results showed that former NFL players in the AFE <12 group had significantly lower FA in anterior three CC regions and higher radial diffusivity in the most anterior CC region than those in the AFE ≥12 group. This is the first study to find a relationship between AFE to RHI and later-life CC microstructure. These results suggest that incurring RHI during critical periods of CC development may disrupt neurodevelopmental processes, including myelination, resulting in altered CC microstructure and greater vulnerability to aging processes.

KEYWORDS: AXONAL INJURY; Diffusion Tensor Imaging; HEAD TRAUMA; PEDIATRIC BRAIN INJURY; TRAUMATIC BRAIN INJURY

Cross-sectional study:
Example 2

Neurology. 2015 Mar 17;84(11):1114-20. doi: 10.1212/WNL.0000000000001358. Epub 2015 Jan 28.

Age of first exposure to football and later-life cognitive impairment in former NFL players.

Stamm JM[1], Bourlas AP[1], Baugh CM[1], Fritts NG[1], Daneshvar DH[1], Martin BM[1], McClean MD[1], Tripodis Y[1], Stern RA[2].

Author information

Abstract

OBJECTIVE: To determine the relationship between exposure to repeated head impacts through tackle football prior to age 12, during a key period of brain development, and later-life executive function, memory, and estimated verbal IQ.

METHODS: Forty-two former National Football League (NFL) players ages 40-69 from the Diagnosing and Evaluating Traumatic Encephalopathy using Clinical Tests (DETECT) study were matched by age and divided into 2 groups based on their age of first exposure (AFE) to tackle football: AFE <12 and AFE ≥12. Participants completed the Wisconsin Card Sort Test (WCST), Neuropsychological Assessment Battery List Learning test (NAB-LL), and Wide Range Achievement Test, 4th edition (WRAT-4) Reading subtest as part of a larger neuropsychological testing battery.

RESULTS: Former NFL players in the AFE <12 group performed significantly worse than the AFE ≥12 group on all measures of the WCST, NAB-LL, and WRAT-4 Reading tests after controlling for total number of years of football played and age at the time of evaluation, indicating executive dysfunction, memory impairment, and lower estimated verbal IQ.

CONCLUSIONS: There is an association between participation in tackle football prior to age 12 and greater later-life cognitive impairment measured using objective neuropsychological tests. These findings suggest that incurring repeated head impacts during a critical neurodevelopmental period may increase the risk of later-life cognitive impairment. If replicated with larger samples and longitudinal designs, these findings may have implications for safety recommendations for youth sports.

Cross-sectional study

How to identify a suitable group?

- Clearly define your “exposure” and “outcomes”
- Use Montage to create an Excel data set (broad inclusion criteria)
- Create (and write down) all classification rules
- Systematically review and code individual patient records

- Document and discuss any questionable cases; revise rules as needed

Cross-sectional study

Is age associated with the type and/or severity of youth football injuries?

Predictor: Patient's age
Outcome: A. Type of injury (body part)
B. Severity of injury (mild/severe)

Age group	Mild injury	Severe injury	% severe injuries
6-8 y	A	B	A/(A+B)
9-11 y	C	D	C/(C+D)
12-14 y	E	F	E/(E+F)
15-17 y	G	H	G/(G+H)

Case-control study: Key features

- Two groups (‘cases’ with a disease/condition; ‘controls’ without)
- All outcomes and exposures have already happened

	Case (has outcome)	Control (does not have outcome)
Exposed		
Not exposed		

Sampling strategy is based on the presence of the “outcomes”

Case-control study

J Neurotrauma. 2015 Jul 17. [Epub ahead of print]

Cavum Septum Pellucidum in Retired American Pro-Football Players.

Gardner RC[1,2], Hess CP[3], Brus-Ramer M[3], Possin KL[1], Cohn-Sheehy BI[1], Kramer JH[1], Berger MS[4], Yaffe K[2,5,6], Miller B[1], Rabinovici GD[1].

Author information

Abstract

Previous studies report that cavum septum pellucidum (CSP) is frequent among athletes with a history of repeated traumatic brain injury (TBI), such as boxers. Few studies of CSP in athletes, however, have assessed detailed features of the septum pellucidum in a case-control fashion. This is important because prevalence of CSP in the general population varies widely (2% to 85%) between studies. Further, rates of CSP among American pro-football players have not been described previously. We sought to characterize MRI features of the septum pellucidum in a series of retired pro-football players with a history of repeated concussive/subconcussive head traumas compared with controls. We retrospectively assessed retired American pro-football players presenting to our memory clinic with cognitive/behavioral symptoms in whom structural MRI was available with slice thickness ≤2 mm (n=17). Each player was matched to a memory clinic control patient with no history of TBI. Scans were interpreted by raters blinded to clinical information and TBI/football history, who measured CSP grade (0-absent, 1-equivocal, 2-mild, 3-moderate, 4-severe) and length according to a standard protocol. Sixteen of 17 (94%) players had a CSP graded ≥2 compared with 3 of 17 (18%) controls. CSP was significantly higher grade ($p<0.001$) and longer in players than controls (mean length±standard deviation: 10.6 mm±5.4 vs. 1.1 mm±1.3, $p<0.001$). Among patients presenting to a memory clinic, long high-grade CSP was more frequent in retired pro-football players compared with patients without a history of TBI.

KEYWORDS: concussion; magnetic resonance imaging; septum pellucidum; traumatic brain injury

Case-control study

- Extension of case-series
- Good for studying rare diseases
- But, requires very careful attention to selection of appropriate controls to avoid bias

Goals & learning objectives

- Be able to list the key features of a case report, case-series, cross-sectional study, cohort study, case-control study
- Be able to describe how Montage could be used to help identify suitable subjects for each kind of these studies based on existing medical records at Children's

Tasks accomplished:

Formulate your research question
Draft a study outline
Use Montage to explore the feasibility of your idea

Next steps:

Clarify your definitions of the ‘predictor/exposure’ and ‘outcome’ variables
Clarify your subject selection criteria
Revise your study outline