The Diagnosis and Treatment of the Acute Scrotum in Children and Adolescents

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Diagnosing acute scrotal pain and swelling in children and adolescents is urgent and often difficult. A review of 395 boys hospitalized with acute scrotal pain and/or swelling shows that a useful approach is to divide these patients into four groups—those with intermittent but recurrent episodes of pain, those with pathognomonic physical findings, those with definite epididymitis, and a remaining group with nonspecific swelling and tenderness. Five per cent of boys in this series presented with recurring episodes of scrotal pain; these boys should undergo a simple scrotal operation that yields excellent results. Eight per cent had pathognomonic physical findings; treatment in these boys is straigntforward. Eighteen per cent had a definite diagnosis of acute epididymitis (*i.e.*, three nonpathognomonic but suggestive findings of acute epididymitis or two suggestive findings plus a radionuclide scan showing bilateral perfusion); nonoperative therapy is indicated in this group. In the remaining boys, scrotal exploration is the diagnostic (and usually therapeutic) procedure of choice.

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ACUTE SCROTAL PAIN REQUIRING hospital admission occurs with 1/20 the frequency of acute abdominal pain.[1] Because of this lower frequency and the wide variety of physicians consulted, few clinicians have a large personal experience. The major problem in the acute scrotum is diagnosis; once the diagnosis is established, treatment is straightforward. The diagnostic problem is difficult because pathognomonic findings are only infrequently present[2–5] and because urgency is needed in those cases due to torsion of the spermatic cord since spermatogonia usually die within 6 to 24 hours of the onset of symptoms.[6–8] Approaches advocated for the acute scrotum vary from prompt exploration of every patient[9] (implying that accurate differentiation on the basis of history, physical exam, and laboratory studies is impossible) to selective exploration of only those boys believed to have a torsion. Physicians who believe in the selective approaches have published little data regarding the reliability of various symptoms, signs, and laboratory tests useful in differentiating among the possible causes of the acute scrotum. The purpose of this paper is to review the relative frequency (prior probabilities) of the possible causes of acute scrotal pain and swelling severe enough to require hospitalization in children and adolescents; to determine the reliability (sensitivity and specificity) of certain historic, physical, and laboratory findings in differentiating among these causes of the acute scrotum; and to examine the results in a large series of patients to determine where improvements might be made.

Patients and Methods

The charts were reviewed in all boys from 30 days of age through 17 years of age who were admitted to St. Francis, St. Joseph, or Wesley Hospitals, Wichita, Kansas, and Children's Hospital, Columbus, Ohio for acute scrotal pain and swelling between 1971 and 1980. The historic findings reviewed were the age of the patient; the side of involvement; the duration of the pain prior to seeking medical attention; the mode of onset of the pain; the presence of nausea or vomiting; a current history of dysuria, frequency, urethral discharge, or recent cystoscopy; a past history of urinary tract infection, abnormal bladder function, an imperforate anus, or a hypospadius repair; a history of prior similar episodes; and a history of an injury at the onset of the pain. The physical findings reviewed were the admission temperature; the presence of a palpable nodule or a visible blue dot between the upper pole of the testis and the head of the epididymis; tenderness or erythema localized to the upper scrotum; tenderness or induration localized to the epididymis; the presence of a palpable twist in the spermatic cord; the major axis of the involved and contralateral testicles; and the orientation of the epididymis within the scrotum. The laboratory findings re-

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viewed were the results of the urinalysis; the total leukocyte and differential counts; and the radionuclide testicular scan. The discharge diagnoses were accepted as the final diagnoses when confirmed by the findings at surgical exploration or when the historic data, physical findings, laboratory studies, hospital course, and follow-up exams all substantiated the discharge diagnosis. All cases of testicular torsion and 94 of the 96 cases of torsion of a testicular appendage were confirmed by exploration at the initial or a subsequent hospitalization. Only 25 of the 125 cases of acute epididymitis were verified by operative exploration.

A number of cases of scrotal pathology occurred that were excluded because they did not present as an acute painful or swollen scrotum without an obvious etiology. These excluded cases were 12 cases of neonatal testicular torsion; three cases of acute inflammatory hydroceles that occurred within 3 weeks of a peritoneal infection (perforated appendicitis or necrotizing enterocolitis); three cases of hard nonpainful scrotal masses that were biopsied with a preoperative diagnosis of tumor but that were found to be chronic inflammation of the epididymis; and an unknown number of infarcted testicles following incarceration of an inguinal hernia. No cases of acute scrotal pain and swelling due to acute appendicitis in an inguinal hernia, infarction of omentum in an inguinal hernia, scrotal fat necrosis, Henoch-Schönlein purpura, or Kawasaki disease were found.

Results

Three hundred and ninety-five charts were reviewed. The three major diagnostic categories in the differential diagnosis of acute scrotal pain in children were torsion of the spermatic cord, acute epididymitis, and torsion of an appendage testis. These three diagnoses comprised 94% of these cases. Less common diagnostic categories were idiopathic testicular infarction, idiopthic scrotal edema, and no pathology found on scrotal exploration. The relative frequencies (prior probabilities) of these diagnoses are shown in Figure 1.

Of the 150 boys with torsion of the spermatic cord, 20 had elective prophylactic fixations because of recurrent episodes of scrotal pain. Of the 130 boys with acute irreversible torsion of the spermatic cord, 125 were explored at the initial hospitalization. The remaining five were diagnosed and treated as acute epididymitis on the initial hospitalization. These five boys were subsequently readmitted either for a contralateral orchidopexy after atrophy of the testicle had occurred and the correct diagnosis was recognized (two patients) or because a persistent, hard testicle remained after the acute inflammation had subsided and exploration to rule out tumor showed necrosis of the testicle (three patients). Of the 96 boys discharged from the hospital

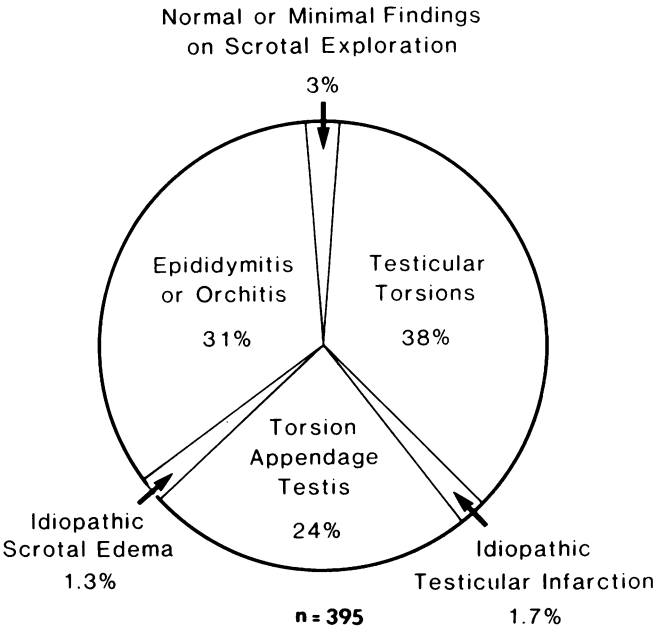


FIG. 1. Final diagnoses in 395 boys 17 years of age or younger hospitalized for acute scrotal pain and swelling.

with a diagnosis of torsion of the appendix testis, 94 had operative confirmation and two had clinical diagnoses substantiated on the basis of a tender nodule palpable in the groove between the testis and the head of the epididymis along with the gradual onset of their pain without nausea or vomiting, a normal temperature, and a normal urinalysis. Of the 125 boys with a discharge diagnosis of acute epididymitis, 33% lacked documentation on retrospective review that their acute scrotal pain and swelling was clearly caused by inflammation of the epididymis.

Twelve boys underwent exploration with no definite diagnostic findings on direct inspection of the intrascrotal contents; six had normal findings and six had nonspecific abnormalities such as small hydroceles containing clear fluid, petechiae in the tunica albuginea of the testis, or focal erythema without induration of the epididymis. Seven patients had partial or total infarction of the testicle without torsion being noted and without a history of a preexisting incarcerated inguinal hernia. Four presented with acute pain and swelling; two had total infarction and two had partial infarction of the testicle. The other three boys presented with a swollen testicle without a prior history of pain and were explored for tumors through an inguinal incision; two had histologic findings indicating painless torsion of the spermatic cord[10] and one had findings suggestive of epididymo-orchitis with infarction.[11] Five boys had idiopathic scrotal edema, but only one was diagnosed on admission. Two of these youngsters with bilateral swelling underwent scrotal exploration, finding marked edema of the sub-

TABLE 1. *Diagnostic Groups and Clinical Subgroups in Boys with Acute Scrotal Pain and Swelling*

I. Testicular torsion				150
Prophylactic fixations			20	
Acute torsions			130	
Torsion of undescended testes		2		
Torsion of testis on epididymis		2		
Torsion of spermatic cord		126		
Viable Testis	56			
Infarcted testis	52			
Questionable outcome	18			
II. Acute epididymitis–orchitis				125
Definite epididymitis—orchitis			41 (4*)	
Gram-negative bacteria	6			
Chlamydia trachomatis	4			
Nonspecific epididymitis	29			
Mumps	2			
Probable epididymitis–orchitis			30 (9*)	
Gram-negative bacteria	6			
N. Gonorrhoeae	1			
Mumps, coxsackie, mononucleosis	4			
Nonspecific epididymitis	19			
Possible epididymitis			47 (12*)	
Questionable epididymitis			7 (0*)	
III. Torsion of appendage testis				96
Clinical diagnoses			2	
Proven torsions			94	
IV. Negative or minimal nonspecific findings on scrotal exploration				12
V. Idiopathic partial or complete testicular infarction				7
VI. Idiopathic scrotal edema				5
Total				395

* Number with operative confirmation of acute epididymitis.

cutaneous tissue and dartos muscle and normal intrascrotal contents. The other two were diagnosed retrospectively on the basis of young age, bilateral scrotal involvement with marked edema but mild discomfort, and rapid resolution without specific treatment. Further data regarding subgroups of the major diagnostic categories are listed in Table 1.

The cases of acute torsion of the spermatic cord, acute epididymitis, torsion of an appendage testis, and idiopathic scrotal edema were next analyzed to see which historic, physical, or laboratory findings were helpful in differentiating among these four diagnoses. No pathognomonic historic findings or laboratory tests were found. Eight per cent of these boys had findings on physical examination that were absolutely diagnostic of the underlying disease process. The pathognomonic findings for torsion of the spermatic cord were an abnormal elevation of the affected testicle with a palpable twist in the spermatic cord (six boys), an abnormal axis to the testicle when the youngster was examined in an upright position (five boys), an abnormal position of the epididymis within the scrotum (two boys), and an abnormal axis in the contralateral testicle (one boy) (Fig. 2). The specific physical findings for torsion of a testicular appendage were a palpable tender mass in the groove between the testicle and the head of the epididymis (11 boys) or a blue dot visible through the stretched scrotal skin at this location (two boys). There were no pathognomonic physical findings for acute epididymitis. A certain diagnosis of idiopathic scrotal edema cound be made in prepubertal boys with bilateral scrotal erythema and edema but with little tenderness of the intrascrotal contents.

The remainder of the useful ($p > 0.05$ on either χ^2 or t-tests) but not pathognomonic findings are listed in Table 2 for brevity of presentation. Since most of us do not have minds that deal well with means and standard deviations, the age is plotted as distributions in Figure 3. An attempt was made to assess the severity of the pain from the recorded history for each known cause of the acute scrotum; no objective method of quantifying pain was apparent. Consequently, two indirect but quantifiable findings that correlated with the severity of pain were used—the time interval from the onset of pain to when medical attention was first sought and the presence of nausea or vomiting. Although a mean duration of pain for each etiology could be calculated, the duration distributions for all etilogies were skewed and yielded longer time intervals than was representative. Using 24 hours as a dividing point, boys with torsion of the spermatic cord were more likely to promptly seek medical attention than were boys with either epididymitis or with torsion of an appendage testis. Boys with torsion of the spermatic cord more often had nausea or vomiting at the onset of their pain, while nausea or vomiting were uncommon in boys with torsion of an appendage testis.

The mode of onset of the pain varied with the underlying cause. Pain caused by torsion of the spermatic cord was more often, but certainly was not uniformly, of rapid onset. Boys with torsion of an appendage testis more frequently had intermittent episodes of pain over a week's period of time leading to constant pain that resulted in their seeking help. Boys with acute epididymitis were more likely to give a history of gradual onset.

A history of past episodes of similar pain occurring more than 2 weeks preceding the current episode was more probable in boys with torsion of the spermatic cord than in boys with torsion of a testicular appendage or acute epididymitis. A current history of painful voiding, a urethral discharge, a recent cystoscopy, or an indwelling Foley catheter favored a diagnosis of acute epididymitis as did a past history of a urinary tract infection, an imperforate anus, ureteral reimplantation with bladder neck surgery, a neurogenic bladder, or hypospadius surgery.

A history of direct trauma to the scrotum preceding the pain and swelling was a recurring red herring noted

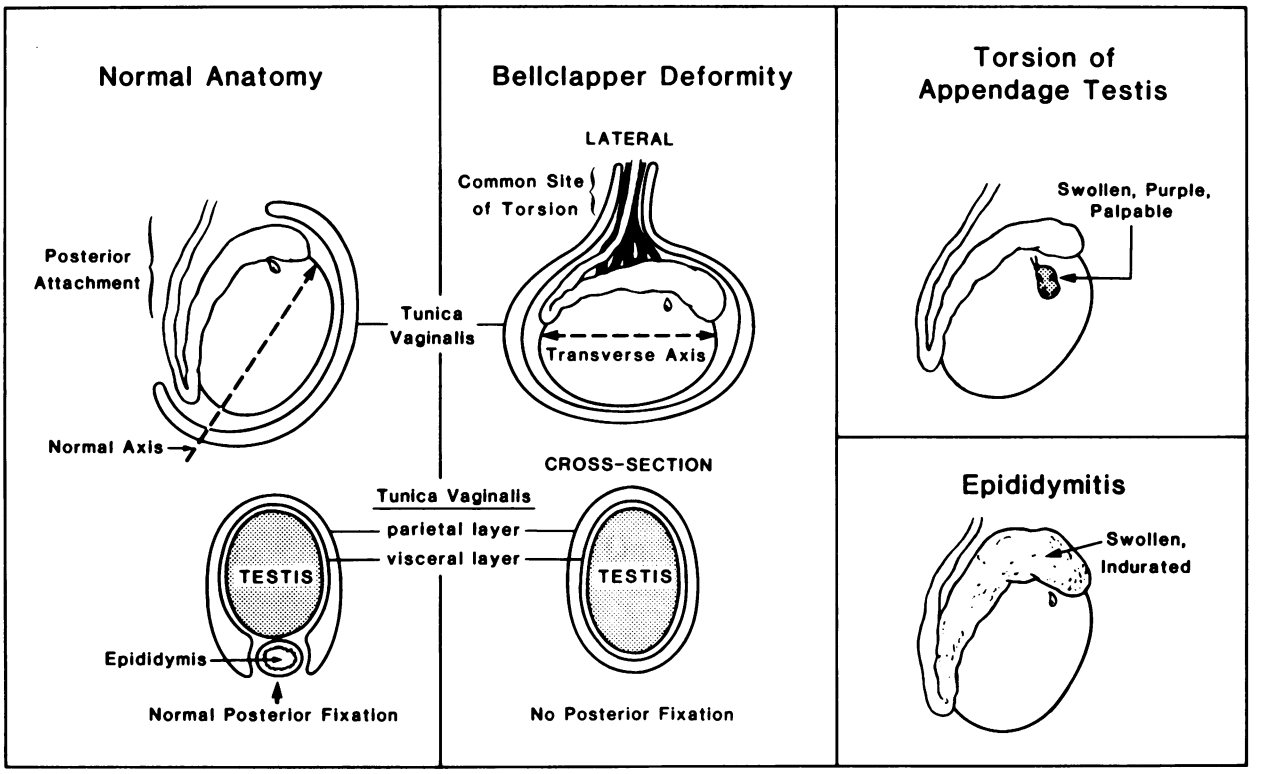


FIG. 2. Physical findings in normal boys and in boys with torsion of the spermatic cord, torsion of an appendage testis, or acute epididymitis.

in 18 boys. An additional 11 boys noted onset of pain and swelling following athletic competition or vigorous exercise without a direct blow to the scrotum. In several cases of torsion of the spermatic cord, this history of trauma misled the physician who was initially consulted and it resulted in the loss of a potentially viable testicle.

The mean admission temperature was higher in boys with acute epididymitis than in boys with torsion of the spermatic cord or torsion of an appendage testis. Since most surgeons' minds handle fixed breakpoints better than means and standard deviations, the data were inspected and 101 F (38.3 C) was selected as a discriminator. Thirty-four of the 37 boys with admission temperatures >101 F had acute epididymitis. Fifteen per cent of these youngsters had two physical findings that were not pathognomonic, but that did favor a particular diagnosis. Localized tenderness without a mass and erythema of the scrotal skin in the region of the upper pole of the testis favored a diagnosis of torsion of an appendage testis; tenderness and induration localized to the epididymis favored a diagnosis of acute epididymitis. However, early acute torsion of the spermatic cord or torsion of an appendage testis also occasionally presented with swelling and tenderness apparently limited to the epididymis.

Two findings were recurring sources of confusion. The first was the early localization of the pain from a torsed testicle to the lower abdomen. Several boys were sent home from the emergency room with diagnoses of "gastroenteritis," "muscle spasm," or "constipation" before the correct diagnosis became apparent. This error was common in younger, less communicative patients. One 4-year-old had a normal appendix removed when his abdominal pain and anorexia failed to improve after overnight hospital observation; the following day, a red swollen scrotum was noted and torsion of the spermatic cord was found at exploration. A second area of recurring confusion was the belief that diffuse erythema and swelling of the scrotal skin and diffuse tenderness of the scrotal contents were caused by an infectious inflammatory process (*e.g.*, bacterial epididymitis) rather than merely being late manifestations of any of the causes of the acute scrotum. As shown in Table 2, there are no absolutely specific physical findings for acute epididymitis.

Fifteen per cent of these boys had an abnormal urinalysis. The urinalysis was considered abnormal if the urine sediment showed ten or more leukocytes (WBCs) per high-power field (HPF) with or without increased erythrocytes (42 boys), ten or more erythrocytes (RBCs) per HPF without an increased number of WBCs (seven boys), or definite bacteria without an increased number of WBCs or RBCs (one boy). Of the 50 abnormal urine sediments, 43 (86%) occurred in boys with acute

TABLE 2. *Symptoms, Signs, and Laboratory Results* Versus *Final Diagnoses*

	Acute Torsion of the Spermatic Cord (N = 130)	Torsion of a Testicular Appendage (N = 94)	Acute Epididymitis Orchitis (N = 125)	Idiopathic Scrotal Edema (N = 5)
Pathognomonic physical findings				
Yes	14	13	0	5
No	116	81	125	0
Age (years)				
Mean ± SD	13.0 ± 3.5	9.9 ± 2.9†	13.1 ± 3.0	6.0 ± 2.8†
Side				
Right	52	47	64	0
Left	78	47	59	0
Bilateral	0	0	1	5‡
Duration of pain				
≤24 hours	74*	26	41	4‡
>24 hours	56	67	75	1
Nausea, vomiting				
Vomiting	45 } *	3 } *	14 }	0
Nausea, no emesis	8 }	1 }	4 }	0
No, not mentioned	77	90	107	5
Mode of onset of the pain				
Acute continuous	67*	20	22	0
Intermittent pains	2	15*	4	0
Gradual continuous	21	22	46*	3
Not mentioned	39	33	50	1
No pain	2	4	2	1
Past episodes of similar pain				
Yes	30*	3	7	0
No, not mentioned	100	91	118	5
Current dysuria, Urethral discharge, Recent cysto, Foley				
Yes	2	0	23*	0
No, not mentioned	128	94	102	5
Past history of UTI, imperforate anus, abnormal bladder, hypospadius repair				
Yes	1	1	16*	0
No, not mentioned	129	93	109	5
Admission temperature (F)				
Mean ± SD	98.38 ± 1.77	98.54 ± 1.52	100.52 ± 0.79†	98.7
≥101 F	2	1	34*	0
<101 F	125	88	88	4
Suggestive but not specific physical findings				
Tenderness or erythema localized to the upper scrotum	3	15*	2	0
Tenderness and induration localized to the epididymis	3	2	33*	0
Urinalysis				
≥10 WBC, ≥10 RBC/HPF	5	2	43*	0
Normal	115	84	79	4
Total leukocytes				
≤10,000	50	66*	56	4
>10,000	64	23	59	1
Leukocyte differential				
Normal	44	64*	44	4
>70% segs or >5% bands	67	13	62	0

* Chi squared with $p < 0.05$.
† T-test with $p < 0.05$.
‡ Fischer exact with $p < 0.05$.

epididymitis. Almost one-half of the total leukocyte counts were greater than 10,000/mm^3 and almost one-half of the differential leukocyte counts showed greater than 70% neutrophils or greater than five per cent unsegmented neutrophils. The only discriminating value of the leukocyte count was that boys with torsion of a testicular appendage were less likely to have a leukocytosis or left shift than boys with either torsion of the spermatic cord or acute epididymitis.

Radionuclide testicular scans came into use during the mid-portion of this study and they were at first used enthusiastically. There was a steep learning curve with

the scans; five of the 38 were misinterpreted or overinterpreted, leading to prolonged hospitalizations and delays in operative treatment until the boy's findings failed to resolve as expected. The two misinterpretations were due to inappropriate technique in one case and failure to appreciate the scan findings of late torsion of the spermatic cord in the other. The three overinterpretations were due to reading torsion of an appendage testis as acute epididymitis. As experience was gained, it became apparent that both acute epididymitis and torsion of a testicular appendage showed similar scan findings of normal or increased perfusion on the involved side. While a technically adequate scan interpreted by an experienced physician can differentiate testicles without perfusion from testicles with normal or increased blood flow with at least a 95% accuracy,[12] the scan cannot differentiate torsion of a testicular appendage from acute epididymitis.

The next problem is how to combine the useful but not pathognomonic findings listed in Table 2 to decide whether a boy with acute scrotal pain requires an operation or is better treated nonoperatively. Inspection of these data show that six findings are suggestive of a diagnosis of acute epididymitis-orchitis that would not benefit from exploration. These findings are gradual onset of pain; a current history of pain with urination, a urethral discharge, a recent diagnostic cystoscopy, or an indwelling Foley catheter; a past history of urinary tract infections, imperforate anus, an abnormality of bladder emptying, or a hypospadius repair; an admission temperature >101 F (38.3 C); tenderness and induration localized to the epididymis; or an abnormal urine sediment showing ≥10 WBC/HPF or ≥10 RBC/HPF. These six findings were compared to each other using the χ^2 test, looking for associations that would indicate that the results of one of these findings would influence the results of another finding, thus lessening the usefulness of the second finding in the diagnosis of epididymitis or orchitis. Although knowledge of pathophysiologic mechanisms suggests that a past history of urinary tract infections or a current history of urethral discharge should influence the presence of ≥10 WBC/HPF in the urine sediment, the largest association among the 15 χ^2 tests had a p value of only 0.30. Consequently, each of these six findings can be used independently in making a diagnosis of epididymitis. The data were examined to see how many of these six findings were needed to differentiate cases of acute epididymitis from all other causes. If three or more findings per patient were present, epididymitis was the only diagnosis. If two of these findings were present, four boys with proven torsion of the spermatic cord and one boy with torsion of an appendage would have been misdiagnosed as acute epididymitis. If only one finding was required, 57 boys with either torsion of the spermatic cord or of an appendage would have been misdiagnosed. Consequently, boys who had at least three of the above six findings were classified as definite epididymitis; those with two findings as probable epididymitis; boys with a single finding as possible epididymitis; and those with none of these findings as questionable epididymitis (Table 1).

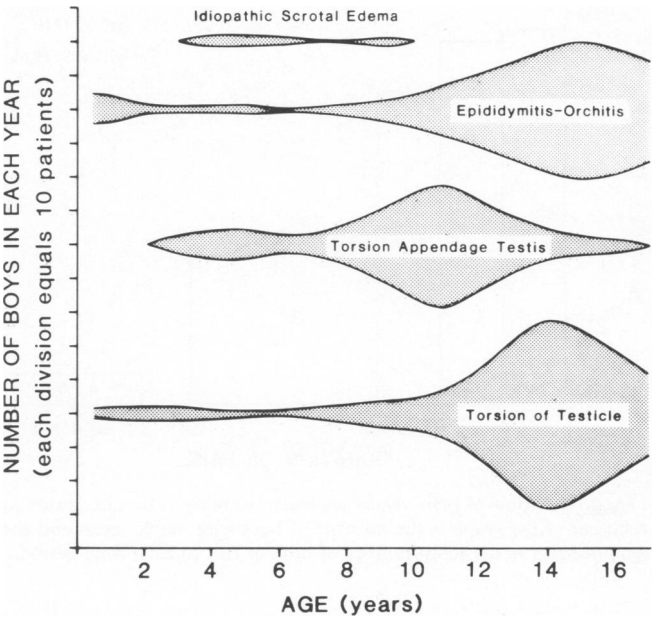


FIG. 3. Age distributions for the various causes of acute scrotal pain and swelling in children. Despite considerable overlap, age is useful in diagnosing idiopathic scrotal edema and torsion of an appendage while it is not helpful in discriminating between torsion of the spermatic cord and acute epiditymitis in adolescents.

In addition to knowing the preevaluation betting odds and the reliability of various historic, physical, and laboratory findings in refining these odds for any patient, several other pieces of outcome data are needed to formulate a logical approach to the boy with an acute scrotum. The first of these is the realization that when a diagnosis is not apparent at admission, rarely is new data of diagnostic value obtained during a period of hospital observation. Although the pain did resolve or improve in eight boys to the point where they were discharged, seven of these eight subsequently were readmitted for surgery for either recurrent torsion of the spermatic cord (three boys) or recurrent pain and swelling from an ongoing torsion of an appendage testis (four boys). Subsequent physical exams are rarely as useful as the admission examination since edema and tenderness tended to progress and obscure any localizing physical findings. While admission for serial exams is frequently a good strategy for the child with acute abdominal pain, admission for serial examinations is a bad strategy in boys with acute scrotal pain.

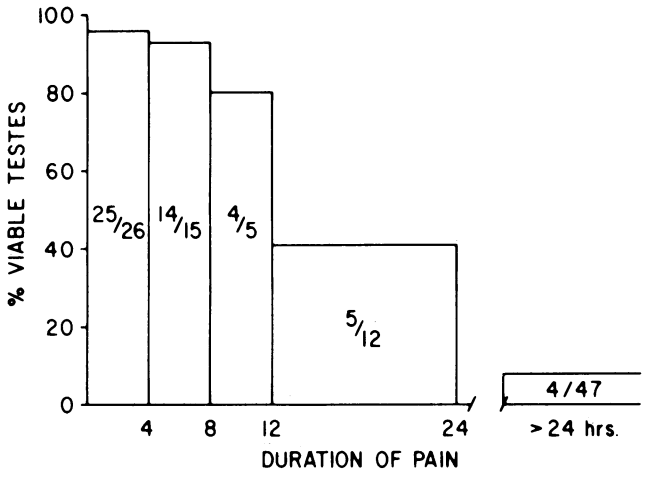


FIG. 4. Duration of pain *versus* testicular viability. The numerator in each bar of the graph is the number of boys with viable testes and the denominator is the total number of boys at risk in each time period.

Outcomes regarding testicular salvage were available for 110 of the boys with an acute torsion of a scrotal testis; data regarding the preoperative duration of pain were available for 105 of these boys and are shown in Figure 4. Of the ten boys who had a nonviable testicle with a history of less than 24 hours of continuous pain, seven had both edema and erythema of the overlying scrotal skin indicating that the torsion had probably been present for a longer period than the patient either perceived or related to the physician. Of the four patients who had viable testicles despite a history of continuous pain for more than 24 hours duration, none were described as having erythema and only one had edema of the overlying scrotal skin.

Ten of the 130 boys undergoing operation for acute testicular torsion did not undergo simultaneous or planned delayed contralateral orchidopexy. In one of these 10 cases, this was due to a previous contralateral orchiectomy for an undescended testicle; in the other nine, contralateral orchidopexy was omitted for unknown reasons. Two of these nine boys developed an acute torsion of the contralateral unpexed testicle during the study period (average follow-up of 5 years). Three of the 120 boys who did undergo a prophylactic contralateral orchidopexy subsequently developed a torsion in this contralateral "fixed" testicle. In these three cases, as well as the majority of cases that did not retorse after prophylactic fixation, chromic catgut suture material was used for fixation.

Discussion

Given the initial diagnostic possibilities, the data regarding the reliability of various clinical findings, and the outcome results mentioned, how can the surgeon decide whether a boy with acute scrotal pain or swelling requires an operation or is better managed nonoperatively? We believe a logical and efficient approach is based on the answers to four questions if two premises are accepted. The first premise is that the treatment of acute epididymitis and idiopathic scrotal edema is nonoperative, and that the treatment of torsion of the spermatic cord and torsion of an appendage testis is operative. There is some controversy whether the majority of boys with torsion of an appendage develop symptoms severe enough to warrant the expense of surgical excision of the offending appendage.[13] Our data do not answer this question since the criterion for inclusion was symptoms severe enough to require hospitalization. When symptoms progress to the point where a boy can no longer go to school or carry out his usual activities, it seems silly to us to relegate him to several weeks of incapacity when he can be dramatically improved within 24 hours with a minor operation.

The second premise is that epididymitis and orchitis, although diseases of diverse and often unknown etiologies, can be reliably diagnosed in the majority of cases by using defined criteria. These criteria are the presence of three or more of the previously mentioned six clinical findings or the presence of two of these findings and a radionuclide scan showing bilateral testicular perfusion. Although others have advocated the scan as the sole diagnostic test to determine whether surgery is needed, we use it less frequently because it is redundant when pathognomonic physical findings are present or when the criteria for epididymitis are already satisfied; it cannot differentiate between epididymitis that is not helped by surgery and torsion of an appendage that often requires surgery for prompt resolution; it too has an inherent error rate; and it is the most expensive and time-consuming to obtain of all the useful pieces of diagnostic information. The four questions are

1. Is this a boy with a history of recurrent episodes of acute scrotal pain? In boys with intermittent episodes of pain, normal physical findings, and an otherwise unremarkable past medical history, one should consider two diagnoses. If the episodes have been several weeks apart with a pain-free interval, especially in a postpubertal boy, the symptoms are probably related to intermittent torsion of the spermatic cord. On the basis of this history alone, a simple scrotal operation (bilateral orchidopexy) is recommended to prevent loss of reproductive capacity. Of the 23 boys who underwent scrotal exploration because of recurring episodes of acute testicular pain, 20 were found to have an anatomic abnormality that predisposed to testicular torsion; two were unexpectedly found to have torsion of an appendage testis; and one had no abnormal findings. With increasing

awareness of the significance of these recurrent episodes of pain, the current five per cent of boys with recognized reversible torsions would hopefully increase. As noted in Table 2, almost one-quarter of the boys with acute irreversible torsion of the spermatic cord had prior but self-limited similar episodes recorded. When orchidopexy is carried out for reversible torsion, the salvage is 100%; when irreversible torsion has already occurred, the salvage is only 50% (Fig. 4).

If the episodes of pain are on a daily basis and seem to be following a crescendo pattern of increasing frequency and severity, especially in a prepubertal boy, the diagnosis of torsion of an appendage testis is likely. The sage physician will advise the boy's parents of this tentative diagnosis and the need for excision of the offending embryologic remnant if the symptoms progress and erythema and induration of the upper scrotum develop. While there is no threat to the boy's reproductive capacity, disability will be minimized by prompt excision of the necrotic appendage.

2. Are pathognomonic findings present on physical examination? Although pathognomonic physical findings were recorded in only eight per cent of our cases, this figure would increase if physicians were better aware of what to look for in cases that present early before swelling and exquisite tenderness mask the clinical findings. All cases of idiopathic scrotal edema and a fraction of the cases of torsion of the spermatic cord and torsion of an appendage can be diagnosed on the basis of pathognomonic physical findings. Once the diagnosis is determined, treatment is straightforward—observation or oral antihistamines for idiopathic scrotal edema, usually emergency exploration for torsion of the spermatic cord, and elective exploration for torsion of an appendage testis.

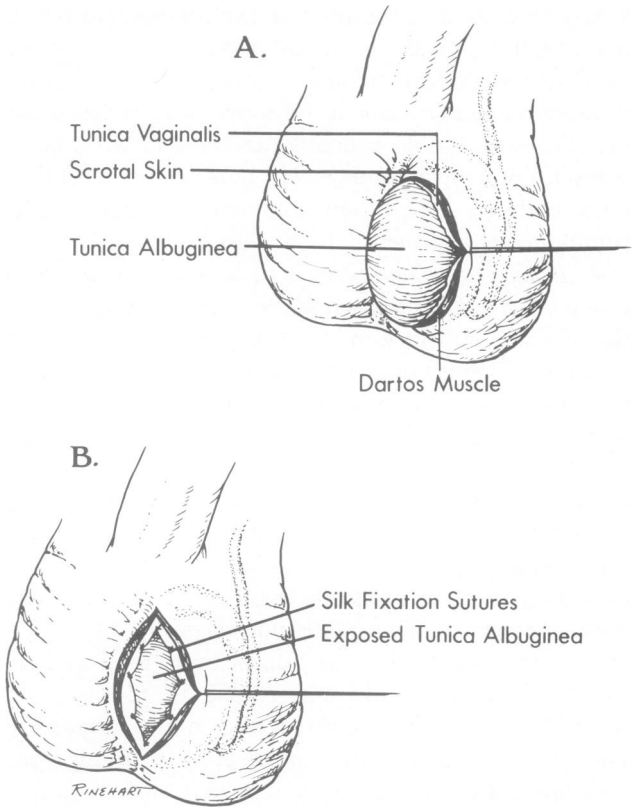
3. Can acute epididymitis or orchitis be definitely diagnosed? If one accepts three findings suggestive of epididymitis or two findings plus a scan showing bilateral testicular perfusion as diagnostic of epididymitis or orchitis, 60% of the cases classified as epididymitis or orchitis could have been definitely diagnosed. With more complete data in the charts, this percentage would have been higher.

After excluding boys with recurrent episodes of scrotal pain, boys with pathognomonic physical findings, and boys with a definite clinical diagnosis of epididymitis, one is left with a residual group. This group largely consists of boys who present late with diffuse swelling and exquisite tenderness precluding any meaningful physical examination. Using the data from Table 2, it is possible to calculate a revised list of posterior probabilities for each patient. However, since over three-fourths of these boys will have either torsion of the spermatic cord or torsion of an appendage testis that would be treated at the time of exploration, we believe that exploration is the most cost-effective next diagnostic step. Although further sifting and sorting is possible using radionuclide scans in boys who do not fall within preselected threshold probabilities for the two types of torsion, fewer hospital days will be required if all these boys undergo exploration for diagnosis and usually simultaneous treatment.

4. If surgical exploration is indicated, is it an emergency or can it be performed electively? Our data show that if a boy with torsion of the spermatic cord has both a history of continuous pain of over 24 hours duration and also has erythema and edema of the overlying scrotal skin, the affected testicle is infarcted. The goal of scrotal exploration is no longer to salvage the affected testicle, but only to prevent the subsequent loss of the contralateral testicle due to a similar predisposing anatomic abnormality and to remove the dead testicle to hasten recovery. In cases due to torsion of an appendage testis, emergency operation is not necessary. Only those cases with both continuous pain of more than 24 hours duration and erythema and edema of the overlying scrotal skin can be safely deferred either because the patient has recently eaten or because operating room staff are not readily available. In boys with symptoms for less than 24 hours or without erythema and edema of the overlying scrotal skin, the overlap in clinical findings between torsion of the spermatic cord and torsion of an appendage testis is often so great that experienced surgeons cannot reliably make this differentiation; only urgent scrotal exploration can be recommended for these cases.

In those boys who are thought to have torsion of the spermatic cord and who require urgent exploration because of symptoms of less than 24 hours duration or because of the absence of scrotal edema and erythema, an attempt should be made to manually detorse and the spermatic cord while waiting for an operating room.[14,15] This is best accomplished with short-acting intravenous analgesia rather than by infiltration of the cord with a longer-acting local anesthetic; the boy's response to the manipulation is a better index of successful detorsion than the physical findings after manipulation.

Whether the boy requires an urgent or an elective surgical exploration, certain technical points merit consideration. Unless there is concern about the possibility of torsion of a testicular tumor (an unlikely occurrence in boys younger than 18 years of age), an inguinal incision should not be used. The inguinal approach turns a simple, superficial operation into a much more involved undertaking that requires complete mobilization of the testicle from above. It is also impossible to adequately stabilize the testicle over a broad insertion



FIGS. 5A and B. Operative technique. *A*. Scrotal raphe incision through which the mobile left testis is delivered for inspection and detorsion and/or excision of appendages. *B*. After detorsion and replacement, the tunica albuginea testis is sutured to an anterior "window" in the parietal layer of the tunica vaginalis in boys with torsion of the spermatic cord. The dartos muscle is then closed over the exposed tunica albuginea testis to form a broad area of adhesion. A similar fixation is then carried out on the opposite side.

without making a scrotal counterincision. If a boy has a bellclapper deformity that requires replacement of the congenitally deficient posterior attachment, attachment over the long axis of the testis provides the greatest fixation; this requires a longitudinal rather than a transverse scrotal incision. Either bilateral longitudinal incision or a midline scrotal raphe incision are suitable. The midline scrotal incision gives excellent access and exposure because each testicle can successively be delivered and it saves closing one skin incision (Fig. 5A). The needle point electrocautery facilitates making this incision with minimal bleeding.

After delivering the testicle, torsion of the spermatic cord, torsion of an appendage, or acute epididymitis is usually obvious. In cases of torsion of the spermatic cord, the testis is replaced after detorsion and the contralateral testicle is then pexed. If the torsed testicle fails to regain any pink color during this interval, if only black blood oozes from an incision through the tunica albuginea, and if the patient's symptoms have been present for more than 24 hours, an orchiectomy is indicated. If the testicle regains some mottled color, or if there is red bleeding from the cut edge of the tunica albuginea, or if the patient has had symptoms for less than 24 hours, then the testis should probably be preserved.[8] In our seven cases where a testicle that was probably infarcted was retained, none of the boys had persistent disabling pain or a prolonged hospitalization. Only one of these boys developed a late abscess and slough of the testis through the incision. When orchiectomy is necessary for torsion, consideration should be given to simultaneous placement of a silastic prosthesis for cosmetic and psychologic benefits, even though the scrotum is edematous and erythematous. Although our experience was limited to only four simultaneous prosthesis insertions (all with good results), Harrison[16] performed 17 acute prosthetic insertions with 15 good results.

In addition to our three cases of recurrent torsion of the spermatic cord after surgical fixation with absorbable suture, a number of similar cases have been reported.[17-20] This problem has led to the recommendation to use a permanent reactive suture material like silk for fixation and to expose a portion of the tunica albuginea by suturing the edges of the parietal tunica vaginalis to the tunica albuginea, thus creating a broad anterior fixation to replace the congenitally deficient posterior fixation.[21] This is shown in Figure 5B.

In occasional cases of infarction of an appendage testis, instead of an enlarged purple-black appendage that has undergone venous infarction, there may be only an edematous appendage two to three times its normal size. This results from a very acute torsion with early arterial occlusion or from infarction without torsion. In four of our cases, there was erythema but no induration of the epididymis and marked thickening of the soft tissue and lymphatics behind the epididymis initially thought to be due to some sort of epididymitis. However, histologic review of the excised appendix testis showed no viable surface epithelial cells and varying degrees of inflammatory cell infiltration indicating the true etiology of this "epididymitis."

If induration and erythema confined to the epididymis is found, we have not found that needle aspiration has yielded any purulent material for bacterial culture or for immunologic testing for *Chlamydia,* but only produces a bleeding puncture hole in the inflamed epididymis. Although epididymal biopsies have been carried out,[22] there are no histologic criteria for separating chemical inflammation possibly related to crystalline precipitates from refluxing urine from bacterial or chlamydial epididymitis.

In a small number of cases, direct inspection of the scrotal contents will not yield a diagnosis of torsion of

the spermatic cord, torsion of an appendage, or acute epididymitis. In these cases, a testicular biopsy is indicated to determine if a viral orchitis or a vasculitis like Henoch-Schönlein purpura or Kawasaki disease is responsible for the acute scrotal symptoms.

Comment

Because the sensitivities and specificities for the various clinical findings useful in diagnosing the acute scrotum were not available to the physicians who cared for the boys in this report, it was impossible for them to know which findings to focus on. With a better understanding of the value and the limitations of these findings, a larger percentage of future cases should be included in the groups with recurring episodes of pain, with pathognomonic physical findings, or with definite acute epididymitis. The large residual group that was diagnosed only after scrotal exploration would diminish in size.

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References

1. Williamson RCN. Torsion of the testis and allied conditions. Br J Surg 1976; 63:465–476.
2. Brereton RJ, Manley S. Acute scrotal pathology in boys. Z Kinderchir 1980; 29:343–357.
3. Leape LL. Torsion of testis—Invitation to error. JAMA 1967; 200:669–672.
4. Jones P. Torsion of the testis and its appendage during childhood. Arch Dis Child 1962; 37:214–226.
5. Kaplan GW, King LR. Acute scrotal swelling in children. J Urol 1970; 104:219–223.
6. Smith GI. Cellular changes from graded testicular ischemia. J Urol 1955; 73:355–362.
7. Sonda LP, Lapides J. Experimental torsion of the spermatic cord. Surg Forum 1961; 12:502–504.
8. Moyad R, Barnett B, Lapides J, Soiderer MH. Therapy of questionably infarcted testis. Invest Urol 1975; 12:387–388.
9. Cass AS, Cass BP, Verraraghavan K. Immediate exploration of the unilateral acute scrotum in young male subjects. J Urol 1980; 124:829–832.
10. Lyon RP. Torsion of the testicle in childhood: a painless emergency requiring contralateral orchidopexy. JAMA 1961; 178:702–705.
11. Hourihane DO. Infected infarcts of the testis: a study of 18 cases preceded by pyogenic epididymo-orchitis. J Clin Pathol 1970; 23:668–675.
12. Haynes BE, Besen HA, Haynes VE. The diagnosis of testicular torsion. JAMA 1983; 249:2522–2527.
13. Holland JM, Graham JB, Iquatoff JM. Conservative management of twisted testicular appendages. J Urol 1981; 125:213–214.
14. Burkitt R. Torsion of the spermatic cord: a plea for manipulative reduction. Br Med J 1956; 2:345.
15. Sparks JP. Torsion of the testis in adolescents and young adults. Some comments on clinical expression and management. Clin Pediatr 1972; 11:484–486.
16. Harrison RH. Torsion of the Spermatic Cord, Testis, and Vestigial Appendages. New York: Harcourt Brace Jovanovich, 1982; 60.
17. Johenning PW. Torsion of the previously operated testicle. J Urol 1973; 110:221–222.
18. McNellis DR, Rabinovitch HH. Repeat torsion of "fixed" testis. Urology 1980; 16:476–477.
19. Redman JW, Stalling JW. Torsion of the testicle following orchidopexy. Urology 1980; 16:502–503.
20. May RE, Thomas WE. Recurrent torsion of the testis following previous surgical fixation. Br J Surg 1980; 67:129–130.
21. Morse TS, Hollabaugh RS. The "window" orchidopexy for prevention of testicular torsion. J Pediatr Surg 1977; 12:237–240.
22. Wolin LH. On the etiology of epididymitis. J Urol 1971; 105:531–533.