CASE REPORTS

Aneurysms of the mid axillary artery in major league baseball pitchers—A report of two cases

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True aneurysms of the axillary artery and its branches are rarely identified. Our recent experience with successful repairs of symptomatic aneurysms of the axillary arteries at the origin of the circumflex humeral arteries in 2 major league baseball pitchers suggests a condition that may be more common than recognized previously. We report this unique experience with baseball pitchers to focus attention on a condition that should be considered in all athletes with hand pain, numbness, or signs of digital ischemia. In addition, a schedule of rehabilitation and the timing of an appropriate return to competition is presented. (J Vasc Surg 1998;28:702-7.)

Vascular injuries are relatively rare in baseball players, but occasional reports have described axillary artery compression or thrombosis in the throwing arms of major league pitchers. In 1972, Cooley et al[1] described the successful surgical treatment of a left axillary artery thrombosis in a major league pitcher. A saphenous vein bypass graft was used, and the patient was able to return to pitching. The thrombosis presumably was related to intimal damage caused by the repetition of the strenuous pitching motion. Another notable case of upper extremity arterial thrombosis in a major league baseball pitcher was reported in 1986.[2] This was treated with a subclavian to axillary artery bypass graft with external iliac artery conduits, and the results were less than optimal. Strukel and Garrick[3] and McCarthy et al[4] have described their experiences with upper extremity arterial compression in athletes as a manifestation of thoracic outlet syndrome or as a result of compression by the humeral head. Although subclavian/axillary arterial thrombosis and compression have been noted and well described in athletes, the occurrence of symptomatic upper extremity aneurysms has been considered to be rare.

During the past 2 years, we have repaired identical symptomatic aneurysms of the axillary artery in 2 major league baseball pitchers. We report on this experience to focus attention on a pathologic entity that may be under recognized and to provide guidelines for operative management and postoperative rehabilitation and a timetable for return to competition.

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Case 1. A 33-year-old right-handed major league pitcher was first seen with a recent history of numbness, cyanosis, and decreased temperature of the fingers of his right hand. The symptoms were particularly intense after pitching and especially in cold weather. There was no history of pain in the arm or shoulder. The results of a physical examination revealed palpable axillary, brachial, radial, and ulnar pulses. There were no bruits or abnormal pulsations in the neck, chest wall, supraclavicular fossa, or right upper extremity. A chest x-ray film did not reveal any evidence of cervical ribs. There were no neurologic deficits. Punctate areas of digital ischemia consistent with embolic events were noted on the right second, third, and fourth fingers. The left upper extremity was completely normal. A duplex ultrasound scan examination did not reveal any evidence of aneurysmal or occlusive disease in the subclavian, axillary, or brachial arteries. The results of plethysmographic studies of the digital arteries showed markedly flattened curves in the right second, third, and fourth fingers, with normal tracings

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0741-5214/98/$5.00 + 0 **24/4/93024**

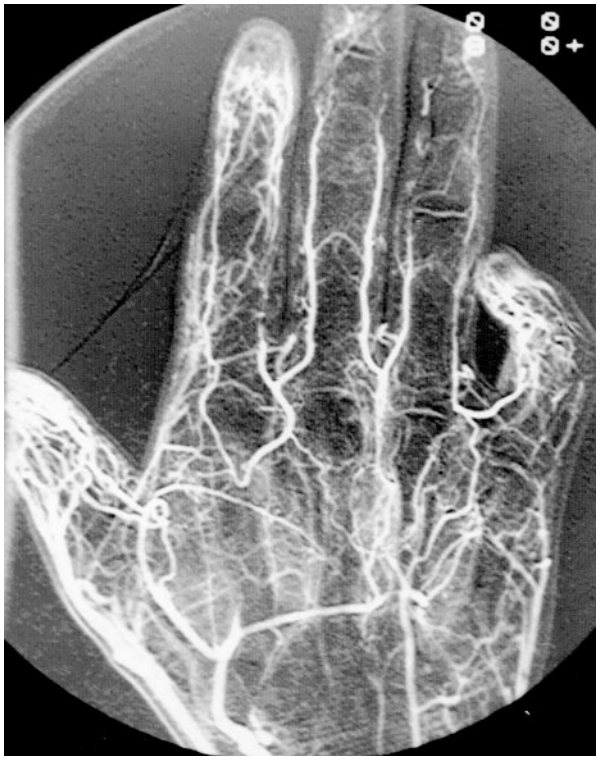

Fig 1. Case 1. Arteriogram shows partial occlusion of digital arteries of second, third, and fourth fingers of right hand.

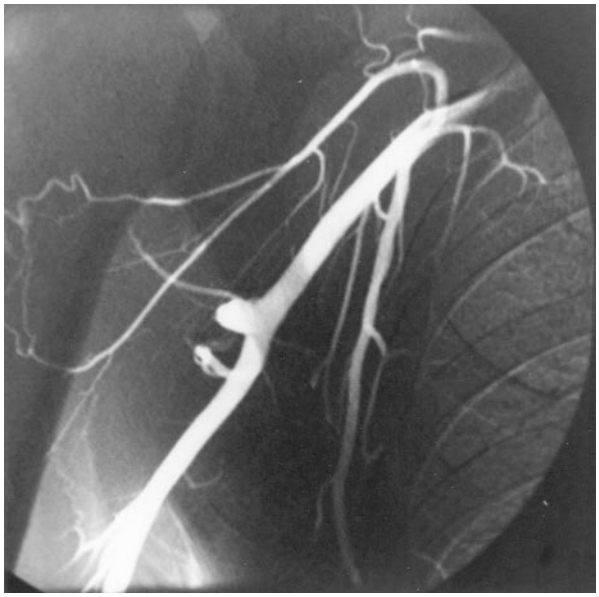

Fig 2. Case 1. Arteriogram shows aneurysm at junction of right axillary artery with circumflex humeral arteries.

of the first and fifth fingers and all of the fingers of the left hand. A conventional contrast arteriogram showed an incomplete palmar arch, partial occlusion of the digital arteries of the second, third, and fourth fingers consistent with emboli (Fig 1), and an aneurysm at the junction of the right axillary, anterior circumflex humeral, and posterior circumflex humeral arteries (Fig 2). No compression of the axillary artery was shown during arteriography with the arm in multiple positions (Fig 3).

The patient was administered intra-arterial urokinase infusion for 36 hours with subjective improvement and improved color and temperature of the hand. The repair was performed on May 10, 1996. The right arm was abducted to 90 degrees. An incision was begun in the axilla and extended to the border of the pectoralis major muscle. The neurovascular bundle was identified, and the dissection proceeded proximally along the surface of the artery, with extreme care being exercised to avoid injury to venous or neuronal structures. No muscle was incised, and no neuronal or venous structures were divided. A 2.0-cm aneurysm was found on the posterior aspect of the right axillary artery at the junction of the anterior and posterior circumflex humeral arteries. The circumflex humeral arteries arose via a common trunk. Both the origin of the circumflex branches and the axillary artery itself were aneurysmal. The aneurysm was excised, and the anterior and posterior circumflex humeral arteries were individually ligated. No thrombus was found within the aneurysm. Arterial continuity was reestablished with a 1-inch segment of reversed saphenous vein that was harvested from the saphenofemoral junction and sutured with 6-0 polypropylene in an end-to-end fashion. After the completion of the proximal anastomosis but before the distal anastomosis was performed, the arm was positioned in abduction, in external rotation, and at the side to be certain that the length of the vein graft was appropriate for the various positions of the arm during the pitching motion. The postoperative course was without complication, and there was rapid clearing of the cutaneous manifestations of digital emboli, with no recurrence during 22 months of follow-up. A pathologic examination of the resected specimen revealed myocyte dropout and fibrosis of the media and damage to the internal elastic membrane. In 1 area, hemosiderin-laden macrophages were noted to be embedded within the medial fibrosis, which suggests that this was the site of an old thrombus. There was marked expansion of the intima by myointimal proliferation and intimal fibrosis. The adventitia was histologically unremarkable.

The rehabilitation program consisted of an active range of motion exercise beginning 6 weeks after surgery, the "soft tossing" of a baseball at 8 weeks, and throwing from the mound at 12 weeks. The pitcher returned to the major league roster, pitched 7 innings of no-hit baseball 4 months after surgery, won the pivotal game of the World Series 5.5 months after the aneurysm repair, and was chosen for the All-Star Team the following season.

The patient returned with right shoulder pain 15 months after surgery. An examination of the arterial system

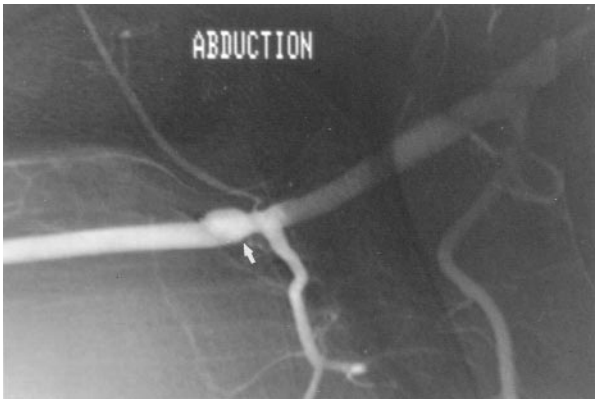

Fig 3. Case 1. Arteriogram shows aneurysm *(arrow)*. There was no evidence of arterial compression with abduction of right upper extremity.

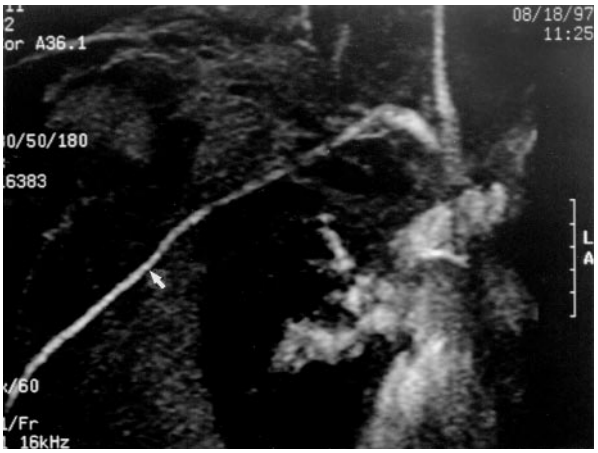

Fig 4. Case 1. Magnetic resonance angiography performed 15 months after aneurysm repair. No stenosis or aneurysmal change is seen at site of vein graft *(arrow)*.

showed completely normal results. As part of the evaluation, magnetic resonance angiography (MRA) of the subclavian-axillary arteries was performed (Fig 4). The arterial repair was found to be completely normal, with no evidence of aneurysm or stenosis. The vein graft was indistinguishable from the normal axillary artery. Magnetic resonance imaging results of the shoulder revealed tendonitis and bursitis.

Case 2. A 27 year-old right-handed major league baseball pitcher was first seen at another center with numbness and cyanosis of the right second finger that began in August 1997. The medical history was unremarkable. There was no history of pain in the arm or shoulder. Physical examination revealed palpable axillary, brachial, radial, and ulnar pulses, with no abnormal pulsations or bruits. An angiogram revealed an aneurysm of the right axillary artery at its junction with the anterior and posterior circumflex humeral arteries (Fig 5). The patient then was referred to our center. On examination, the right hand appeared normal in all respects, and the patient, who had not pitched for more than 1 month, was asymptomatic.

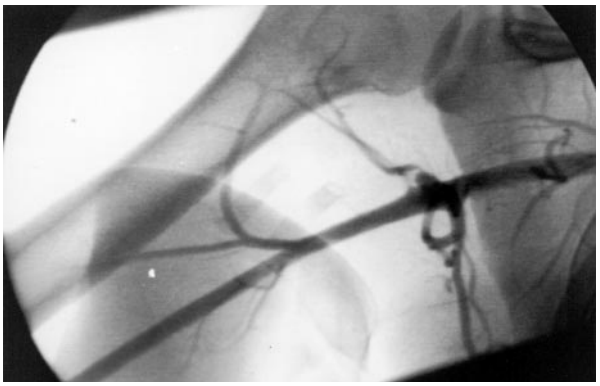

Fig 5. Case 2. Arteriogram shows an aneurysm at junction of right axillary artery with common origin of circumflex humeral arteries.

The repair was performed via a transaxillary approach on October 15, 1997. The procedure was performed in a manner identical to that described for case 1. The findings were essentially identical to those in the previous case, with a true aneurysm at the junction of the right axillary artery with the common origin of the anterior and posterior circumflex humeral arteries. An individual ligation of the circumflex humeral arteries was performed, a 3.0-cm length of axillary artery, which was aneurysmal on the posterior aspect, was resected, and a reversed saphenous vein from the saphenofemoral junction was used to restore arterial continuity—end-to-end anastomosis. The postoperative course was without complication. The results of a microscopic examination of the axillary artery revealed degenerative changes in the media, including deposition of myxoid ground substance, fragmentation of elastic fibers, and loss of waviness of elastic fibers. These findings were considered to be consistent with a diagnosis of cystic medial necrosis. At a follow-up evaluation 6 weeks after the aneurysm repair there were normal arterial examination findings and a normal-appearing duplex ultrasound scan. The pitcher is undergoing a rehabilitation program similar to that described for the first patient.

DISCUSSION

Although most shoulder, arm, and hand pain in baseball pitchers is musculoskeletal in nature, ischemia of the throwing arm has been recognized in major league pitchers. Cooley et al[1] described the successful treatment of a 36-year-old left-handed major league pitcher who was first seen with cramping and fatigue in his pitching arm and who was found to have a complete occlusion of the left axil-

Table I. Aneurysms of the mid axillary artery and branches in athletes. Literature review.

Author (year)	*Sport (age/sex)*	*Signs/symptoms*	*Aneurysm type*	*Treatment*
McCarthy & Yao (1989)	Baseball pitcher RH (28/M)	Digital ischemia	R-PCHA*	Nonoperative
Reekers (1993)	Volleyball RH (23/M)	Digital ischemia	R-PCHA	Resection of aneurysm
	Volleyball RH (25/M)	Digital ischemia	R-PCHA	Embolization with coils
	Volleyball RH (35/M)	Digital ischemia	R-PCHA*	Nonoperative
Kee (1995)	Baseball pitcher LH (25/M)	Digital ischemia	L-PCHA	Resection of aneurysm, lateral repair of axillary artery
	Baseball pitcher RH (22/M)	Digital ischemia	Subscapular artery aneurysm	Resection of aneurysm, lateral repair of axillary artery
Todd (1998)	Baseball pitcher RH (33/M)	Digital ischemia	R-A/PCHA	Resection of aneurysm, vein graft repair of axillary artery
	Baseball pitcher RH (33/M)	Digital ischemia	R-A/PCHA	Resection of aneurysm, vein graft repair of axillary artery
	Baseball pitcher RH (27/M)	Digital ischemia	R-A/PCHA	Resection of aneurysm, vein graft repair of axillary artery

RH, Right handed; *LH,* left handed; *R-PCHA,* right posterior circumflex humeral artery; *L-PCHA,* left posterior circumflex humeral artery; *R-A/PCHA,* right anterior and posterior circumflex humeral artery.
*Patients were found to have thrombosis of the PCHA that was presumed to be caused by an aneurysm of this artery.

lary artery beginning immediately distal to the insertion of the pectoralis minor muscle. A sympathectomy was only partially successful in relieving his symptoms, and he was definitively managed with a saphenous vein bypass graft. The patient was able to return to major league pitching for 1 additional season. We recently had the occasion to examine this patient for an unrelated problem, and his left subclavian to brachial artery saphenous vein bypass graft was noted to be functioning well more than 30 years after surgery.

Right subclavian and axillary artery thrombosis and retrograde propagation of thrombus to the level of the innominate artery were reported in a major league pitcher by Fields et al[2] in 1986. Unfortunately, this patient had a stroke and was never able to regain his pre-injury form. His arterial reconstruction had been accomplished with a conduit fashioned from bilateral autogenous external iliac arteries and replacement of these lower extremity arteries with prosthetic materials in October 1980. He presented in March 1983 with left-leg claudication and required reoperation for a complete occlusion of the left external iliac artery prosthetic graft. In our experience with the 2 cases reported here, the saphenous vein has been a completely satisfactory conduit for the restoration of arterial continuity in the axillary position. The question of whether the vein graft would be able to withstand the stress of pitching at the major league level would seem to be answered by the experience thus far with case 1. An MRA performed 15 months after surgery and after many major league pitching outings showed the vein to be of normal caliber and indistinguishable from the adjacent axillary artery (Fig 4). Before the performance of the MRA, we had followed the vein graft in case 1 with frequent color duplex ultrasound scan examinations as the patient proceeded through the various stages of his rehabilitation. We consider the color duplex ultrasound scan examination to be a satisfactory method for follow-up evaluation of the vein graft. The postoperative MRA was performed in case 1 only because the patient was already undergoing shoulder magnetic resonance imaging to evaluate shoulder pain 15 months after aneurysm surgery.

Our opinion is that the vein becomes "arterialized," and as such, we see no indication for either prosthetic or arterial conduits. Whether a vein patch or a venous conduit is used should be dictated by the anatomic features of the case. In the 2 cases presented here, so much of the axillary artery wall was aneurysmal that a venous conduit was considered to be necessary. In both cases, the anterior and posterior circumflex humeral arteries arose as a common trunk—an anatomic variant—and this contributed to the size of the segment of the axillary artery wall that required excision. In instances where the circumflex humeral arteries arise separately, a smaller segment of the axillary artery wall might be aneurysmal and, therefore, a vein patch angioplasty would probably be more appropriate. It is of interest that both of our patients had the anatomic variant of a common origin of the anterior and posterior circumflex humeral arteries. Whether this is an important feature in the

development of these aneurysms will become clearer as additional cases are identified and treated.

Rohrer et al[5] reported a case of a 28 year-old major league baseball pitcher who was first seen with axillary artery thrombosis that was successfully managed with thrombolytic therapy. Axillary artery thrombosis recurred after he returned to pitching. Again, it was managed with thrombolysis. The pitcher subsequently was maintained with subcutaneous heparin after each pitching appearance with no further episodes of thrombosis. The cause of the thrombosis of the third portion of the axillary artery was considered to be compression of the axillary artery by the humeral head during the pitching motion. Symptomatic upper-extremity arterial insufficiency also has been described as a result of muscular compression without actual thrombosis of the compressed artery. In a series of 11 athletes with upper-extremity ischemic symptoms caused by axillary or subclavian artery compression, McCarthy et al[4] described 5 baseball pitchers who were treated by resection of either the anterior scalene muscle (3 patients), the pectoralis minor muscle (1 patient), or both the pectoralis minor and the anterior scalene muscles (1 patient). One additional patient in their report was described as a minor league pitcher with gangrene of the third fingertip who was treated nonoperatively for a thrombosis of the right posterior circumflex humeral artery. In view of more recent data, one can speculate that this patient had a posterior circumflex humeral artery aneurysm that led to distal embolization and subsequent thrombosis.

Posterior circumflex humeral artery aneurysm associated with distal embolization was described by Reekers et al[6] in 1993. Their report described 2 volleyball players with digital ischemia who were found to have aneurysms of the right posterior circumflex humeral arteries at the junction with the axillary arteries. One patient was treated surgically, and the other underwent coil embolization of the posterior circumflex humeral artery. An additional patient was described with digital ischemia that was attributed to thromboangiitis obliterans. About 4 years later, the patient underwent angiographic reevaluation and was discovered to have an occlusion of the proximal 3 cm of the posterior circumflex humeral artery. The opinion of the authors was that his previous problem was caused by embolization from a posterior circumflex humeral artery aneurysm that subsequently thrombosed spontaneously. Both our patients had signs of embolization to the digital arteries, but thrombus was not identified in either aneurysm at the time of surgery. In case 1, the pathologist made a point of indicating that hemosiderin-laden macrophages were noted to be embedded within the medial fibrosis, which suggested that this was the site of an old thrombus. It would seem that thrombus, which forms in the axillary aneurysm, embolizes readily, probably in large part as a result of the forces imparted to the artery during the pitching motion.

The occurrence of this newly recognized condition that caused embolization to the arm and hand in 3 volleyball players led the authors to suggest that the condition was "a volleyball player's disease." A report from Kee et al[7] in 1995 described a similar condition in 2 baseball pitchers with digital ischemia of the pitching hand that was found to be caused by embolization from the aneurysmal branches of the axillary artery. These pitchers were treated by ligation of the aneurysmal branch vessel—posterior circumflex humeral in a left-handed pitcher and subscapular artery in a right-handed pitcher—and lateral patch angioplasty repair of the axillary artery. In the 2 cases presented in our report, both the circumflex humeral vessels and the axillary artery itself were aneurysmal and it was necessary to replace the axillary artery with a vein graft. We considered the possibility of ischemic necrosis of the humeral head as a consequence of ligation of both the anterior and posterior circumflex humeral arteries. Although this remains a theoretical possibility, it has not been described in the available literature. To revascularize the anterior and posterior circumflex humeral arteries by either direct reimplantation into the vein graft used for replacement of the axillary artery or by individual vein grafts from a normal segment of the axillary artery seemed to us to be a recreation of the mechanism of injury. On this basis, revascularization of the circumflex humeral arteries was rejected as an option in our patients. There has been no suggestion of ischemic necrosis of the humeral head in either of our 2 patients.

Aneurysms of the axillary artery and its branches are now clearly known as a condition that can probably occur in any athletic activity that is associated with repetitious, forceful extension of the upper extremity. The mechanism of injury is likely the repeated abduction and external rotation of the upper extremity with downward displacement of the humeral head. The circumflex humeral arteries arise from the third portion of the axillary artery, either separately or as a common trunk, encircle the surgical neck of the humerus, and provide the main arterial supply to the head of the humerus. This configuration creates a tethering effect on the axillary artery and maintains the artery in a fixed position

relative to the humerus. It was postulated by Durham et al[8] that this anatomical situation in association with the downward displacement of the humeral head during forceful abduction and external rotation leads either to the compression of the more proximal axillary artery or to the stretching of this vessel at its junction with the circumflex humeral arteries. The direct compression of the axillary artery can lead to intimal damage and thrombosis, and a repetitious stretching motion at the point of fixation by the circumflex humeral arteries can lead to repeated arterial injury and aneurysm formation of the circumflex humeral arteries or the axillary artery itself. This condition is suspected to most likely occur in baseball pitchers, but such aneurysms should be considered in any athlete with signs and symptoms suggestive of digital ischemia.

REFERENCES

1. Tullos HS, Erwin WD, Woods GW, Wukasch DC, Cooley DA, King JW. Unusual lesions of the pitching arm. Clin Orthop 1972;88:169-82.
2. Fields WS, Lemak NA, Ben-Menachem Y. Thoracic outlet syndrome: review and reference to stroke in a major league pitcher. AJNR Am J Neuroradiol 1986;7:73-8.
3. Strukel RJ, Garrick JG. Thoracic outlet compression in athletes: a report of four cases. Am J Sports Med 1978;6:35-9.
4. McCarthy WJ, Yao JST, Schafer MF, Nuber G, Flinn WR, Blackburn D, et al. Upper extremity arterial injury in athletes. J Vasc Surg 1989;9:317-27.
5. Rohrer MJ, Cardullo PA, Pappas AM, Phillips DA, Wheeler HB. Axillary artery compression and thrombosis in throwing athletes. J Vasc Surg 1990;11:761-9.
6. Reekers JA, denHartog BMG, Kuyper CF, Kromhout JG, Peeters FLM. Traumatic aneurysm of the posterior circumflex humeral artery; a volleyball player's disease? JVIR 1993;4:405-8.
7. Kee ST, Dake MD, Wolfe-Johnson B, Semba CP, Zarins CK, Olcott C. Ischemia of the throwing hand in major league pitchers: embolic occlusion from aneurysms of the axillary artery branches. JVIR 1995;6:979-82.
8. Durham JR, Yao JST, Pearce WH, Nuber GM, McCarthy WJ III. Arterial injuries in the thoracic outlet syndrome. J Vasc Surg 1995;21:57-70.

Submitted Apr 6, 1998; accepted Jul 6, 1998.