

# Nonoperative Management and Novel Imaging for Posterior Circumflex Humeral Artery Injury in Volleyball

Daan van de Pol, MD, PhD<sup>1</sup>; R. Nils Planken, MD, PhD<sup>1</sup>; Aart Terpstra, RVT<sup>1</sup>; Marja Pannekoek-Hekman, RVT<sup>1</sup>; P. Paul F.M. Kuijjer, PhD<sup>2</sup>; and Mario Maas, MD, PhD<sup>1</sup>

## Abstract

We report on a 34-yr-old male elite volleyball player with symptomatic emboli in the spiking hand from a partially thrombosed aneurysm of the posterior circumflex humeral artery (PCHA) in his dominant shoulder. At initial diagnosis and follow-up, a combination of time-resolved and high-resolution steady state contrast-enhanced magnetic resonance angiography (CE-MRA) enabled detailed visualization of: (1) emboli that were not detectable by vascular ultrasound; and (2) the PCHA aneurysm, including compression during abduction and external rotation (ABER provocation). At 15-month follow-up, including forced cessation of volleyball activities over the preceding 9 months, the PCHA aneurysm remained unchanged. Central filling defects in the palmar arch and digital arteries resolved over time and affected arterial vessel segments showed postthrombotic changes. Digital blood pressure values improved substantially and almost normalized during follow-up. In conclusion, this case report is the first to show promising results of nonoperative management for a vascular shoulder overuse injury in a professional volleyball player as an alternative to invasive therapeutic options.

center for state-of-the-art noninvasive and invasive vascular imaging. Fifteen months later, he was reevaluated.

## Case Report

### Initial Presentation

At the end of the national volleyball playoffs, the 34-yr-old right hand-dominant male volleyball player was referred to a vascular surgeon at our medical center. He reported a 2-yr history of ischemic symptoms of his spiking hand, for example, cold, pale, and painful digits, which initiated in the second and third digits and had recently expanded to the fourth and fifth digits. Since the start of the playoff season, with increased match frequency (up to three a week), he continuously experienced cold, discoloration, and numbness. The athlete is a middle blocker, has played volleyball for 28 yr at semiprofessional level, and for

## Introduction

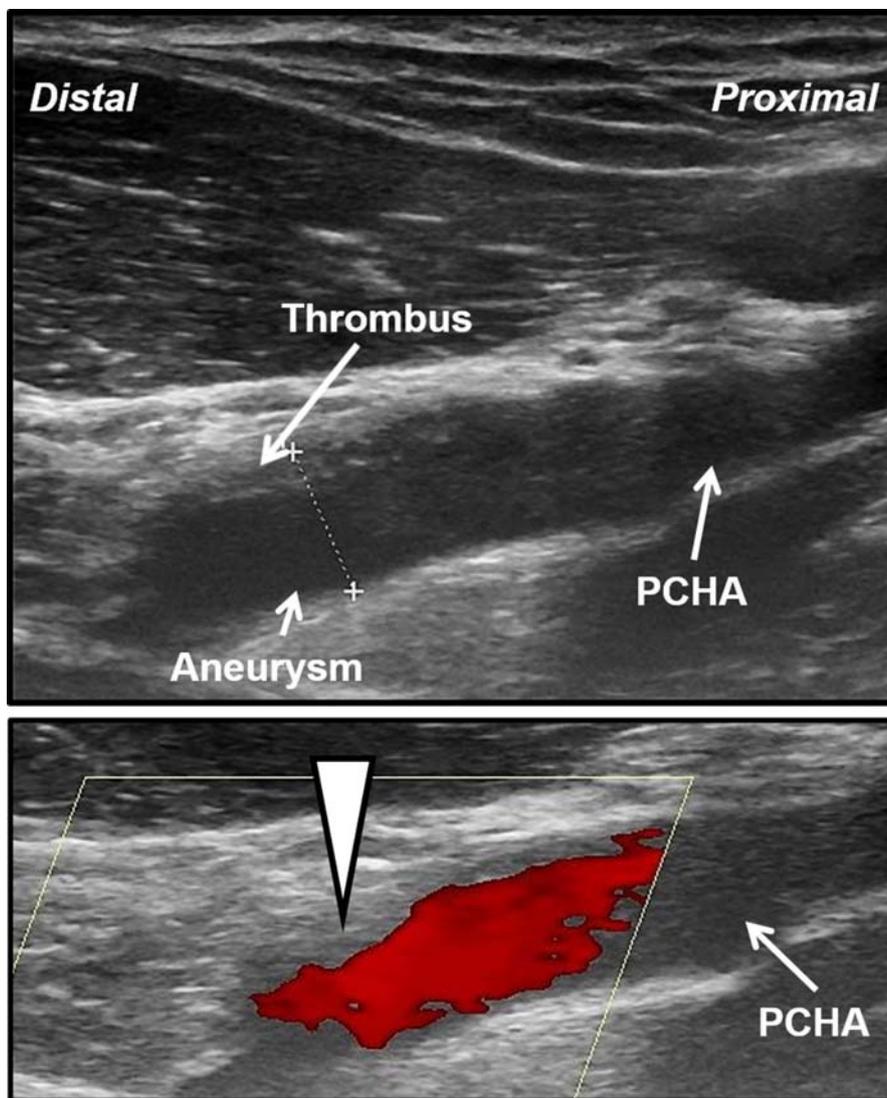
We present a case of a 34-yr-old elite volleyball player with symptomatic emboli in the spiking hand and a partially thrombosed aneurysm of the posterior circumflex humeral artery (PCHA) in his dominant shoulder, who was selected in the context of an onsite ultrasound surveillance study. He was advised about follow-up and referred to our tertiary medical

10 h-wk<sup>-1</sup>. He has a part-time office job, is a nonsmoker with no medical history and no medication use and reports no cardiovascular disease in first-degree family. Physical examination confirmed cold and discolored digits and abnormal capillary refill (digits II, III, IV, and V). Subungual petechiae were present in the fourth digit. The Modified Allen test was positive implying normal blood flow in the ulnar artery. Radial artery and ulnar artery pulsations were normal. No clinical abnormalities were present in the left hand. State-of-the-art vascular ultrasound examination using the standardized and accurate SPI-US protocol (5,9) revealed a partially thrombosed proximal PCHA aneurysm in his right/spiking shoulder (Fig. 1). The palmar arch and digital arteries could not be depicted during ultrasound assessment, and therefore neither the presence nor the absence of digital emboli could be demonstrated. Noninvasive digital arterial blood pressure evaluation revealed abnormal pressure values at the level of the proximal phalanx (digits I-V: 159, 144, 149, 159, 0 mm Hg) and middle phalanx (digits II-IV: 85, 97, 81 mm Hg) of the right hand, and

<sup>1</sup>Department of Radiology and Nuclear Medicine, Academic Medical Center/University of Amsterdam, Amsterdam, THE NETHERLANDS;  
<sup>2</sup>Coronel Institute of Occupational Health, Amsterdam Public Health research institute, Academic Medical Center/University of Amsterdam, THE NETHERLANDS

Address for correspondence: Daan van de Pol, MD, PhD, Department of Radiology, Academic Medical Center/University of Amsterdam, P.O. Box 22700, NL-1100 DE Amsterdam, The Netherlands; E-mail: daanvandepol@gmail.com.

1537-890X/1605/317-321  
Current Sports Medicine Reports  
Copyright © 2017 by the American College of Sports Medicine



**Figure 1:** Upper panel: longitudinal B-mode ultrasound image of the aneurysmatic proximal PCHA with intravascular thrombus in a 29-yr-old professional volleyball player. Lower panel: color Doppler ultrasound image of the aneurysmatic proximal PCHA. Note there is no color flow in the thrombus region (*arrowhead*).

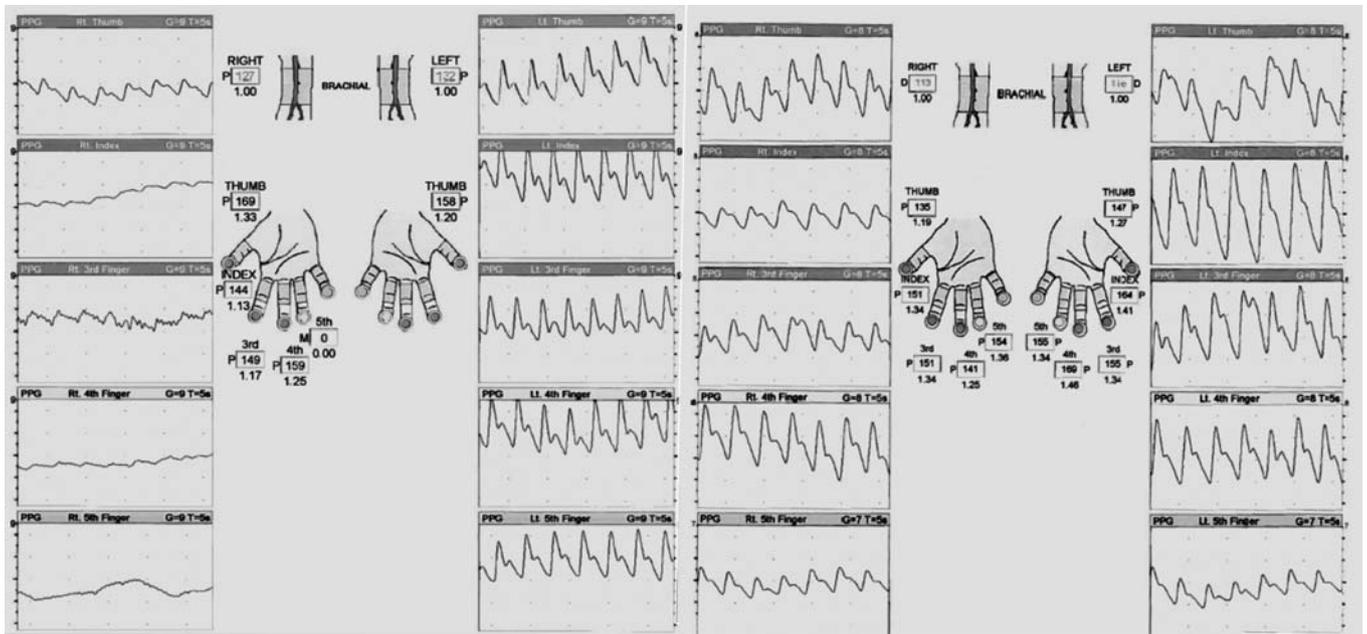
photoplethysmographic curves were nontriphasic in digits II-V, both indicative of inadequate perfusion of digits II to V (Fig. 2, left panel). Additional diagnostic testing was warranted to exclude other proximal arterial pathologies (*e.g.*, thoracic outlet syndrome [TOS]) as a cause of digital ischemia and to differentiate local arterial injury (comparable to ulnar artery injury in hypothenar hamer syndrome). Invasive arterial digital subtraction angiography (DSA) is considered the standard of reference for this purpose. However, DSA may lead to complications such as arterial dissection, perforation, and embolization. In the presented elite volleyball player, we preferred magnetic resonance imaging (MRI) as a less-invasive advanced imaging technique to assess the presence of proximal upper-extremity arterial pathology and digital emboli. In the MRI protocol, we combined time-resolved—and high-resolution steady state—contrast-enhanced magnetic resonance angiography (CE-MRA) acquisitions. The arterial inflow was imaged twice; with the right arm in abduction and external rotation (ABER provocation) position and with the

arm in anatomic position. Filling defects and multiple emboli were detected in the distal radial artery, palmar arch, common palmar artery, and digital arteries (Fig. 3), which corresponded to the abnormal non-invasive digital arterial pressure values. Moreover, the PCHA aneurysm was assessed and depicted in two positions: (1) supine anatomic position (diameter, 8 mm; length, 25 mm at 8 mm from the PCHA origin); and (2) during ABER provocation, to simulate spiking and serving during volleyball, which showed compression of the distal part of the aneurysm (Fig. 4). The remaining arterial runoff down to the hand showed no abnormalities.

After careful consideration, the athlete decided not to undergo surgery or drug therapy. The athlete was discharged without oral antithrombotic medication.

#### 15-Month Follow-Up

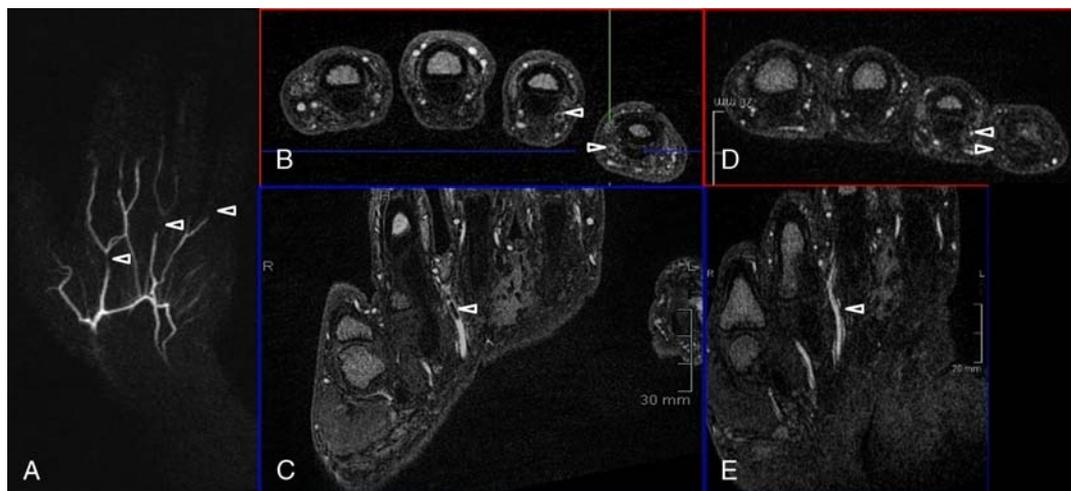
After 15 months, follow-up was performed. Complete cessation of volleyball activities over the preceding 9 months (due to an eye injury) caused us to wonder what anamnestic



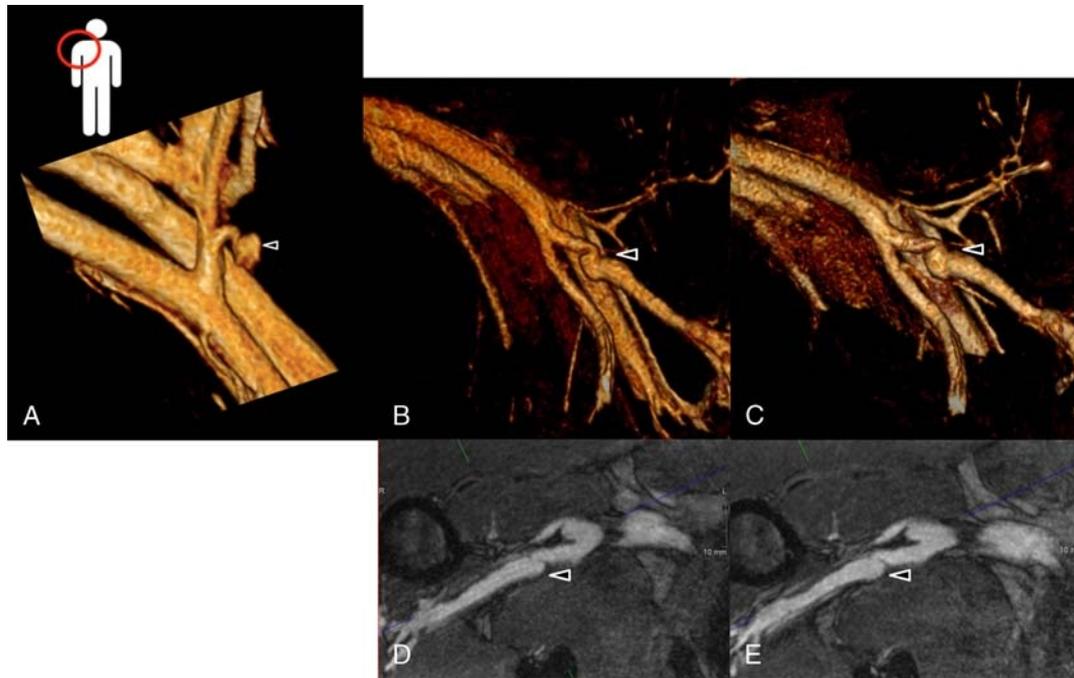
**Figure 2:** Left panel (initial presentation): abnormal digital arterial blood pressure values at the level of the proximal phalanx (digits I-V: 159, 144, 149, 159, 0 mm Hg) and middle phalanx (digits II-IV: 85, 97, 81 mm Hg). Photoplethysmographic waveform patterns were non-triphasic in all digits of the right hand. The left hand shows no abnormalities. Right panel (follow-up): Normal digital arterial blood pressures and photoplethysmographic waveform patterns in both hands on follow-up.

and imaging changes had occurred. The discoloration, numbness, and pain in the spiking hand had disappeared, and he only reported cold digits in the right hand while playing outdoor tennis in the winter time, which disappeared instantly in warm circumstances. Physical examination revealed no clinical abnormalities in the right hand, and the subungual petechiae were resolved. Radial artery and ulnar artery pulsations were normal. Vascular ultrasound examination again revealed the partially thrombosed PCHA aneurysm in his right/spiking

shoulder without intravascular thrombus. Noninvasive digital arterial blood pressure evaluation revealed normal pressure values at the level of the middle phalanx (digits II-V: 151, 151, 141, 154 mm Hg). Photoplethysmographic curves were triphasic in all digits of the right hand, but remained flattened in digits II and III (Fig. 2 right panel). CE-MRA showed improved vascular patency in the right hand and resolution of central filling defects in the distal radial artery, palmar arch, and digital arteries (Fig. 3). Affected digital artery vessel



**Figure 3:** Contrast-enhanced MR angiography using a 1.5 T MR system (Siemens MAGNETOM Avanto, Siemens Healthcare 2009) after infusion of a blood pool contrast agent (Ablavar, Lantheus Medical Imaging 2009). Resolution  $0.3 \times 0.3 \times 0.3$  mm using a 15-element knee coil. (A) Initial diagnosis scan: maximum intensity projection of time-resolved CE-MRA at initial diagnosis shows filling defects in the distal radial artery, palmar arch, common palmar arteries, and digital arteries (arrowheads). (B) Initial diagnosis scan: cross-sectional multi-planar reconstruction of digital arteries with a central filling defect in digits IV and V (arrowheads). (C) Initial diagnosis scan: longitudinal multi-planar reconstruction of the hand with a central filling defect in the common palmar artery (arrowhead). (D) Follow-up scan: resolution of thrombus and decreased artery diameters in digits IV and V (arrowheads). (E) Follow-up scan: resolution of thrombus in the common palmar artery (arrowhead).



**Figure 4:** Contrast-enhanced MR angiography using a 1.5 T MR system (Siemens MAGNETOM Avanto, Siemens Healthcare 2009) after infusion of a blood pool contrast agent (Ablavar, Lantheus Medical Imaging 2009). Resolution  $0.6 \times 0.6 \times 0.6$  mm using a six-element body matrix coil. Volume-rendered images of the axillary artery, branching of the PCHA and proximal PCHA aneurysm (*arrowhead*) in ABER position (A) and anatomic position during diagnosis (B), and follow-up (C). The proximal PCHA aneurysm (*arrowhead*) is largely compressed in the ABER position. Thick slab maximum intensity projections (9 mm) of the PCHA aneurysm (*arrowheads*) at initial diagnosis (D), and follow-up (E).

segments showed postthrombotic changes with decreased diameters and occlusion of some affected segments (Fig. 3). The PCHA aneurysm remained unchanged compared with baseline (Fig. 4).

### Discussion

Although nonoperative treatment has been suggested for PCHA pathology (6,10), to our knowledge, this patient ( $n = 1$ ) study is the first to report on successful nonoperative management for this severe vascular shoulder injury with digital emboli in an elite volleyball player.

After 15 months without antithrombotic medication, and with cessation of volleyball activities over the previous 9 months, the PCHA aneurysm did not show changes compared with baseline. However, distal radial artery, palmar arch, and digital artery intravascular thrombus dissolved. Digital arteries showed postthrombotic changes including narrowing of luminal diameters and some distal occlusions. However, symptoms resolved and physical examination measurements as well as brachial artery and finger pressure measurements almost normalized. The residual symptoms—cold digits during outdoor tennis in the winter—might be the result of demand-ischemia as a result of inadequate vasodilation during outdoor leisure activities in cold circumstances due to postthrombotic vessel changes. Because the athlete did not yet resume volleyball activities, no definitive conclusion as to its normalization can be drawn.

Moreover, this case report is the first to show that a novel combined MR protocol consisting of time-resolved—and high-resolution steady state—CE-MRA enables detailed visualization of symptomatic emboli in the spiking arm and

hand, which are not detectable by vascular ultrasound, and that are in agreement with symptoms and noninvasive hemodynamic measurements. Additionally, this protocol enables visualization of the PCHA aneurysm during ABER provocation, which is of added value to simulate the positional traction and compression of the proximal PCHA during the spiking and serving motion in volleyball. The assumption is that these repetitive powerful overhead movements cause cumulative vessel wall trauma which can lead to a continuum of PCHA pathology ranging from intimal lesions to aneurysmal degeneration with vessel dilatation, intraneurysmal thrombus formation, and occlusion (1,2,4), which can be assessed by the CE-MRA protocol.

Aneurysmal degeneration, thrombosis, and distal occlusion of the PCHA is a rare sport-related overuse injury mostly found among elite volleyball players (7), with a prevalence of 4.6% (8). PCHA thrombosis might lead to distal embolization to the circulation of the forearm, hand, and digits in the ipsilateral limb during the spiking or serving motion in volleyball, when the humeral head acts to compress the aneurysmal PCHA and the intraluminal thrombus, causing retrograde embolism into the axillary artery (1,3,7). Invasive treatment options for thrombosed PCHA aneurysms include surgical ligation and endovascular coiling (1) and are likely to completely reduce the recurrence of emboli. However, this type of therapy does not affect the symptomatic emboli and associated symptoms. It seems that nonoperative management can be considered a valuable alternative for invasive therapeutic options for—partially—thrombosed PCHA aneurysms. However, the combination of antithrombotic medication with cessation of the provoking factor, repetitive powerful overhead

movements, such as spiking and serving in volleyball, might be the key for success and for the feasibility of nonoperative management. Future studies should clarify the effect of nonoperative management on the recurrence of hand ischemia.

### Conclusions

In conclusion, for overuse injury of the PCHA with symptomatic embolization in the spiking arm in a professional volleyball player, this case report is the first to show promising results of nonoperative management as an alternative to invasive therapeutic options, such as surgery or percutaneous interventional techniques.

The authors declare no conflict of interest and do not have any financial disclosures.

D.vd.P. and R.N.P. contributed equally.

### References

1. Atema JJ, Unlü C, Reekers JA, Idu MM. Posterior circumflex humeral artery injury with distal embolisation in professional volleyball players: a discussion of three cases. *Eur. J. Vasc. Endovasc. Surg.* 2012; 44:195–8.
2. Brown SA, Doolittle DA, Bohanon CJ, *et al.* Quadrilateral space syndrome: the Mayo Clinic experience with a new classification system and case series. *Mayo Clin. Proc.* 2015; 90:382–94.
3. Jackson MR. Upper extremity arterial injuries in athletes. *Semin. Vasc. Surg.* 2003; 16:232–9.
4. Reekers JA, den Hartog BM, Kuiper CF, *et al.* Traumatic aneurysm of the posterior circumflex humeral artery: a volleyball player's disease? *J. Vasc. Interv. Radiol.* 1993; 4:405–8.
5. van de Pol D, Alaïkhaneshir S, Kuijer PP, *et al.* Reproducibility of the SPI-US protocol for ultrasound diameter measurements of the posterior circumflex humeral artery and deep brachial artery: an inter-rater reliability study. *Eur. Radiol.* 2016; 26:2455–61.
6. van de Pol D, Alaïkhaneshir S, Maas M, Kuijer PP. Self-reported symptoms and risk factors for digital ischaemia among international world-class beach volleyball players. *J. Sports Sci.* 2016; 34:1141–7.
7. van de Pol D, Kuijer PP, Langenhorst T, Maas M. High prevalence of self-reported symptoms of digital ischemia in elite male volleyball players in the Netherlands: a cross-sectional national survey. *Am. J. Sports Med.* 2012; 40:2296–302.
8. van de Pol D, Maas M, Terpstra A, *et al.* Ultrasound assessment of the posterior circumflex humeral artery in elite volleyball players: aneurysm prevalence, anatomy, branching pattern and vessel characteristics. *Eur. Radiol.* 2017; 27:889–98. Jun 2; [Epub ahead of print].
9. van de Pol D, Maas M, Terpstra A, *et al.* B-mode sonographic assessment of the posterior circumflex humeral artery—the SPI-US protocol: a technical procedure in 4-steps. *J. Ultrasound. Med.* 2016; 35:1015–20.
10. Volckaert K, Geukens L, Peers K, Lysens R. [Thromboembolism of the posterior circumflex humeral artery in a professional volleyball player] [article in Dutch]. *Tijdschr Voor Geneesk.* 2014; 70:1076–9.