Class IIA ring avulsion injuries: An absolute indication for microvascular repair

The class II ring avulsion category,1 includes those patients in whom only digital arteries are damaged but all other structures are intact and functional (here labeled class IIA). Current literature suggests this is a rare lesion. Seven patients with this specific injury in whom the affected digits were nonviable are reported. Four of the seven were misdiagnosed on initial emergency room evaluation. Two did not seek additional medical attention and the condition progressed to necrosis and amputation. The other two, who sought additional treatment because of progressive ischemia, and three additional patients who were correctly diagnosed on initial examination underwent simple digital arterial repair. All digits operated on survived and demonstrated near normal function. Since failure to operate results in digital loss, this is an absolute indication for microvascular repair. (J HAND SURG 9A:810-15, 1984.)

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Ring avulsion injuries range in severity from simple abrasions to complete degloving or amputation. Urbaniak et al.1 reviewed the literature and proposed a simplified classification in order to emphasize principles of treatment. Classification and treatment recommendations are: class I, circulation adequate—standard bone and soft tissue treatment sufficient; class II, circulation inadequate—vessel repair preserves viability, permitting immediate or delayed repair of other tissues2; and class III, complete degloving or amputation—judgment required since revascularization of a nonfunctional digit will result in a "parasitic member."3 (Fig. 1).

The class II category, however, includes a very important subgroup of patients in whom digital artery integrity is compromised but bone, tendons, nerves, and veins are intact. We have arbitrarily labeled them class IIA. Passing reference to this situation is made in the article of Urbaniak et al.,1 and only two other references in the literature describe this situation,4,5 which suggests it is a rare occurrence. This article presents seven patients with this specific injury, points out the frequency of misdiagnosis, establishes the anatomic basis of the mechanism of injury, and emphasizes the

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Table I. Comparative distribution of ring avulsion injuries

<table>
<thead>
<tr>
<th>Injury class</th>
<th>Nissenbaum series</th>
<th>Urbaniak et al.1 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I (circulation adequate)</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Class IIA (arterial compromise only)</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Class IIB (inadequate circulation with bone, tendon, or nerve injury)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Class III (complete degloving or amputation)</td>
<td>5</td>
<td>13</td>
</tr>
</tbody>
</table>

Fig. 1. Class III ring finger avulsion injury with complete degloving-amputation. Replantation is rarely indicated.
Fig. 2, A-B. Case 1. A 38-year-old farmer who jumped from a haywagon caught his ring finger on a protruding screw. There was dorsal abrasion, and palmar laceration was repaired in a local emergency room. Range of motion (ROM) and sensibility were normal at initial evaluation but the finger was noted to be "cooler." Patient was discharged with vascular compromise unrecognized.

Fig. 2C. Case 1. Progressive sensory loss prompted reexamination 6 hours later; vascular deficit was then obvious.
Table II. Clinical material, class IIA ring finger avulsion injuries

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr)</th>
<th>Sex</th>
<th>Mechanism of injury to ring finger</th>
<th>Accuracy of initial diagnosis</th>
<th>Delay from injury to revascularization</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. R.</td>
<td>38</td>
<td>M</td>
<td>Caught on hay wagon</td>
<td>Incorrect</td>
<td>8.5 hr</td>
</tr>
<tr>
<td>R. L.</td>
<td>32</td>
<td>M</td>
<td>Caught in door</td>
<td>Correct</td>
<td>2.5 hr</td>
</tr>
<tr>
<td>M. A.</td>
<td>41</td>
<td>F</td>
<td>Caught in leash</td>
<td>Correct</td>
<td>3.0 hr</td>
</tr>
<tr>
<td>M. N.</td>
<td>37</td>
<td>M</td>
<td>Caught in machinery</td>
<td>Incorrect</td>
<td>Not vascularized</td>
</tr>
<tr>
<td>E. N.</td>
<td>29</td>
<td>F</td>
<td>Caught around reins</td>
<td>Incorrect</td>
<td>5.0 hr</td>
</tr>
<tr>
<td>A. R.</td>
<td>40</td>
<td>F</td>
<td>Caught in leash</td>
<td>Correct</td>
<td>2.0 hr</td>
</tr>
<tr>
<td>R. G.</td>
<td>32</td>
<td>M</td>
<td>Caught in printing press</td>
<td>Incorrect</td>
<td>Not revascularized</td>
</tr>
</tbody>
</table>

TAM = total active motion; M = male; F = female; R = radial digital artery; U = ulnar digital artery; P = patent; O = nonpatent; MP = metacarpophalangeal; PIP = proximal interphalangeal.

Fig. 2D. Case 1. View during surgery shows intact digital nerves and tendon sheath, avulsed radial digital artery (in forceps), and thrombosed ulnar digital artery at the level of the proximal transverse digital artery.

The fact that it is a situation in which simple microvascular repair means the difference between complete digital loss and normal or near normal function.

Methods and material

Between July 1977 and July 1983, seven patients were seen with ring avulsion injuries, minimal skin laceration, and compromised arterial circulation, but with all other anatomic structures intact and functional (class IIA; Tables I and II). During the same period, three patients were seen with class I (intact circulation) and five with class III (degloving or amputation). Seven patients fell into the class II group (circulation inadequate) but had other injuries such as fractures or nerve, tendon, and/or venous involvement in addition to arterial compromise. These are labeled class IIB injuries and are excluded from this study (Fig. 2).

It is likely that patients with minimal injuries (class I) are not referred and those with complete degloving or amputation (class III) are treated with primary closure at outlying institutions. As a result, the distribution of patients reflected in this series probably does not represent the true distribution of the occurrence of these injuries. Even so, the class IIA lesion would appear to be relatively common.

All patients were initially seen by emergency room or referring physicians prior to my evaluation. Mechanism of injury included the following: Four patients caught a ring on protruding objects, one had a ring caught by reins, and two had a ring caught by leashes.

Of these seven patients, four were misdiagnosed on initial evaluation. The severity of the injury is easily overlooked because a finger can maintain normal ROM and near normal sensation for up to 2 or 3 hours after an injury in which only digital arteries are damaged. Mild venous stasis can simulate capillary filling. Three of the four examiners who did not correctly diagnose the severity of arterial compromise did, however, note decreased temperature of the digit when compared to adjacent fingers. This is a consistent early finding.
Diagnosis is confirmed by Doppler evaluation or by a digital Allen's test.

**Results**

Of the four patients who were misdiagnosed at initial evaluation and discharged, two did not heed subsequent symptoms of progressive neurologic and vascular deficit, which resulted in necrosis of the digit and amputation at or near the MP joint level (Fig. 3). The three patients who were correctly diagnosed initially and the two patients who sought further medical care within 8.5 hours of initial injury because of progressive symptoms of numbness, coldness, pain, and color change had surgical exploration. Essentially similar surgical findings were noted in all.

The two patients whose condition had progressed to complete digital necrosis prior to reevaluation had amputations performed. Both showed digital arteries divided at the level of the proximal transverse digital arteries.

In the five digits revascularized, all ten digital arteries were nonpatent: Seven vessels were completely divided, two were thrombosed, and one was in spasm that was relieved by local adventicectomy. All pathology was located at or just distal to the origin of the proximal transverse digital artery.

Seven digital arteries were repaired. Five required only resection of damaged vessel and direct end-to-end repair. Early in the study, two vessels were treated with interposition reversed vein grafting.

With further experience, microbipolar coagulation of the tethering branches of the digital artery allowed ex-
Fig. 3. Case 4. A 32-year-old man with mechanism of injury and initial pathology similar to that in case 1, with palmar skin laceration repaired in an emergency room after which the patient was discharged. Full ROM and normal sensibility were recorded by initial examiner 1 hour after injury. Patient did not seek additional medical attention until irreversible necrosis was established.

Fig. 4. Tendon sheath and digital vessels demonstrate proximal transverse digital artery. Clinically, these branches are often less oblique and shorter than illustrated here. Dist. Trans. Dig. A., distal transverse digital artery; Inter. Trans. Dig. A., intermediate transverse digital artery; Prox. Trans. Dig. A., proximal transverse digital artery; Br. to VLS, branch to long vinculum; Com. Dig. A., common digital artery. (Reproduced, with permission, from Schneider LH. Hunter JM: Flexor Tendons—Late reconstruction. In Greet DP, editors: Operative hand surgery. New York, 1982, Churchill Livingstone, pp 1375-1440.)

Discussion

Edwards first described the proximal, intermediate, and distal transverse arterial branches that consistently arise from each digital artery. The proximal transverse digital artery enters the flexor tendon sheath just distal to the A-2 pulley. It arises at almost a right angle, tethering the digital artery just at the level of maximal force exerted by the ring finger. This prevents distal migration of the vessels with other soft tissues. Dorsal branches of the digital nerve at this level arise obliquely and course greater elongation.
and course primarily towards the skin, allowing much
greater excursion of the nerve (Fig. 4).

The extent of damage from longitudinal traction on a
ring depends on the tightness of the ring, the weight of
the patient, the period of time the force is applied, and
the mechanism of injury. The tethered digital artery is
at greater risk and can be divided or thrombosed with
minimal or no injury to other structures.

This lesion is not, as current literature suggests, a
rare one. Awareness of the entity and careful initial
examination by the digital Allen's test or by Doppler
evaluation should lead to early exploration and simple
arterial repair. Since all other anatomic structures are
intact, near normal function can be expected after re-
vascularization.

It is doubtful whether any of these digits would have
survived had not arterial repair been performed. All
showed some degree of dorsal contusion and had pro-
gressive ischemic changes characterized by decreasing
sensibility and temperature, increasing pain, and loss of
capillary refill.

In digital amputation or class III ring avulsion in-
juries with compromised function of the joints, ten-
dons, and nerves, injudicious replantation may result in
a parasitic member that "only the patient could love."
Revascularization of class IIA ring avulsion injury,
however, results in as close to a normal digit as possi-
ble. Since failure to operate usually results in digital
loss, this situation creates a strong indication for mi-
crovascular repair.

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