

# Assessment of Ipsilateral Versus Contralateral Proximal Fibula for Use in Distal Radius Osteoarticular Reconstruction

Oluwaseun Akinbo, MD, Steven Shamash, DO, and Robert J. Strauch, MD

## Abstract

Which fibula to harvest for distal radius reconstruction, ipsilateral or contralateral, is subject to debate. In this study, we investigated which proximal fibula is better suited for distal radius osteoarticular reconstruction based on radiographic parameters. Twenty-one proximal fibulas were harvested from adult cadavers. Radiographic fibular inclination angle (coronal plane) and radiographic fibular articular tilt (sagittal plane) were measured, and these parameters were compared with corresponding radius parameters. Mean radiographic fibular inclination angles were 25° (right) and 26° (left), and mean radiographic fibular articular tilts were 13° (right) and 13° (left). The native volar tilt of the radius is re-created when the ipsilateral proximal fibula (with proper styloid placement) is transferred to the ipsilateral wrist; conversely, a dorsal tilt is created when the contralateral proximal fibula is transferred. The ipsilateral proximal fibula is therefore a better radiographic match for distal radius osteoarticular reconstruction in the group we studied.

**R**econstruction of the distal radius after tumor resection, correction of congenital deformities, or trauma is increasingly performed with vascularized proximal fibula transfer.<sup>1</sup> This procedure can be used in adults, and especially in children in whom the need to transfer an open physis can be of paramount importance. However, which fibula to harvest, the ipsilateral or the contralateral, has not been studied systematically. Ihara and colleagues<sup>2</sup> suggested the contralateral fibula for ease of surgical positioning;

Dr. Akinbo is Resident, Department of Orthopedic Surgery, Howard University Hospital, Washington, DC.

Dr. Shamash is from Department of Orthopaedic Surgery, The Valley Hospital, Ridgewood, New Jersey.

Dr. Strauch is Professor of Clinical Orthopedic Surgery, Columbia University Medical Center, New York, New York.

Address correspondence to: Robert J. Strauch, MD, Columbia University Medical Center, 622 W 168th St, PH 11-1119, New York, NY 10032 (tel, 212-305-4272; fax, 212-305-4040; e-mail, [robertjstrauch@hotmail.com](mailto:robertjstrauch@hotmail.com)).

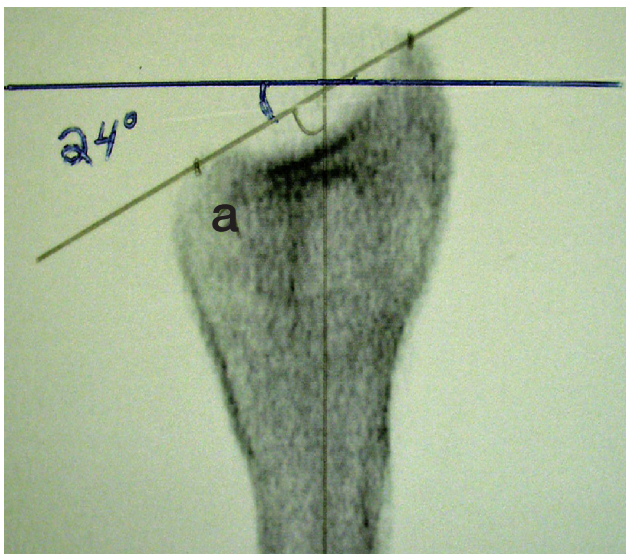
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Innocenti and colleagues<sup>3</sup> preferred the contralateral fibula for distal radius reconstruction because of “anatomical similarities with the distal part of the radius and the proximal part of the contralateral fibula”; other authors did not give a rationale for using the contralateral fibula for this procedure.<sup>4,5</sup> Weiland and colleagues<sup>6</sup> used the ipsilateral fibula in 1 case, but only because the contralateral limb lacked a peroneal artery. Mack and colleagues<sup>7</sup> reported outcomes of 3 cases of ipsilateral fibula autografts and suggested that the ipsilateral graft provides better approximation at the diaphyseal osteosynthesis when styloid placement is anatomical.

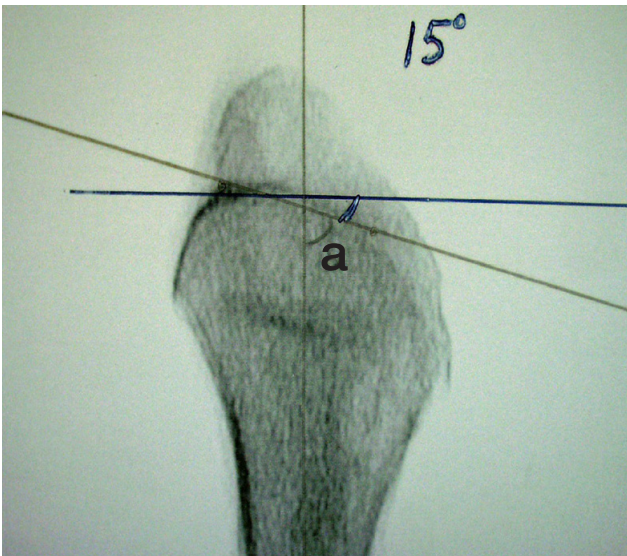
In the study reported here, we used radiographic articular surface parameters to examine which proximal fibula, ipsilateral or contralateral, is better suited for distal radius reconstruction in adults.

## METHODS

Twenty-one proximal fibulas (10 right fibulas, 11 left fibulas) were harvested from 13 adult cadavers (mean age, 85 years). In 8 cadavers, left and right fibulas were harvested; in the other 5 cadavers, only 1 fibula was harvested. The harvested fibulas were then imaged fluoroscopically (OEC Medical Systems, Salt Lake City, Utah), and radio-



**Figure 1.** Radiograph shows radiographic fibula inclination angle. Inclination angle = 90-a.



**Figure 2.** Radiograph shows radiographic fibula articular tilt. Articular tilt =  $90 - a$ .

graphic fibular inclination angles and radiographic fibular articular tilts were measured.

The styloid of each fibula was positioned first to approximate a posteroanterior (PA) view of the radius and then to approximate a lateral view of the radius. Radiographic fibular inclination angle, analogous to radial inclination angle, was measured using a technique similar to that used for radial inclination angle<sup>8</sup>; it was measured as the complement of the angle formed between a line drawn down the shaft of the fibula and a line between the tip of the fibular styloid and the opposite cortex when the fibular styloid assumed a lateral position (Figure 1). Radiographic fibular articular tilt was measured on the lateral view as the complement of the angle formed by a line drawn down the shaft of the fibula and a line between the dorsal and palmar rims of the articular surface as visualized on fluoroscopy (Figure 2). Measurements were repeated and confirmed by 2 of the authors (O.A. and S.A). The proximal fibula may be used for either ipsilateral or contralateral distal radius reconstruction by rotating the fibular styloid 180° one way or the other to simulate the radial styloid of the left or right wrist. Fibular articular tilt was therefore deemed positive if it would produce a volar tilt when transferred to the ipsilateral wrist, or negative if it would produce a dorsal tilt when transferred to the ipsilateral wrist. The fibula was considered ipsilateral when it was on the same side as the radius that would theoretically be reconstructed; the fibula was considered contralateral when it was on the opposite side of the radius that would be theoretically reconstructed.

## RESULTS

Mean (SD) radiographic fibular inclination angle was 25° (4°; range, 20°-34°) for the right and 26° (6°; range, 13°-35°) for the left. Mean (SD) radiographic fibular articular



**Figure 3.** Right proximal fibula with articular surface in hatch marks evidencing grossly similar appearance of proximal fibula and distal radius.

tilt was +13° (3°; range, +7° to +18°) for the right and +13° (4°; range, +7° to +22°) for the left. The shape of the proximal fibula was similar to that of the distal radius when appropriately positioned. The fibular articular surface tilts medially, such that use of the ipsilateral fibula for distal radius reconstruction more normally approximates the radial inclination angle and radial volar tilt.

## DISCUSSION

The proximal fibula has been used for osteoarticular reconstruction of the distal radius. In a growing child, the proximal fibular physis can be transferred to allow continued growth when the physis of the distal radius is sacrificed. However, the present study provides data only for adults (dictated by the age of the fibulas used in the study).

Radiographic parameters for the distal radius typically include radial inclination angle (measured on PA radiograph) and volar or dorsal tilt (lateral radiograph). Radial inclination angle usually ranges from 16° to 28°<sup>9</sup> (mean, 23.8°<sup>10</sup>) and volar tilt from 2° to 20° (mean, 12.1°<sup>11</sup>). These radiographic measurements are similar to those obtained for the proximal fibulas in the present study. No significant difference has been found between measurements of radial inclination and volar tilt in the right wrist versus the left wrist.<sup>12</sup>

Ogden<sup>13</sup> explored the anatomical variation in proximal tibiofibular joints using 84 specimens and 200 roentgenograms. Articular surfaces were exposed, and the inclination of these surfaces was measured; anatomical and radiographic measurements were taken. Angle of inclination of the fibular articular surface varied, but most cases in which this angle was measured anatomically ranged from 10° to 30°. The range derived from the roentgenograms was 10° to 30° as well. Our findings are within the range found by Ogden. Ogden's measure-

ments were taken with the tibiofibular joint intact; ours were taken with the fibula harvested from the actual cadaver specimens.

The proximal fibula resembles the distal radius in shape and size (Figure 3) and, in prior studies, has been found to be particularly suited for reconstruction of the distal radius.<sup>14</sup> Mack and colleagues<sup>7</sup> noted that the proximal fibula roughly approximates the distal radius in diaphyseal width and styloid placement. As the gross appearance of the proximal fibula approximates that of the distal radius, it is of interest to investigate which fibula is the better radiographic fit: ipsilateral or contralateral.

Mack and colleagues<sup>7</sup> recommended the ipsilateral fibula for harvest but did not take into account the articular tilt of the fibula. The articular surface of the proximal fibula has a medial tilt toward the tibia, which forms the proximal tibiofibular joint. In our study, this medial tilt averaged +13° radiographically. As the styloid of the proximal fibula lies posterior, the medial tilt, when transferred to the ipsilateral wrist, assumes a volar tilt, the native tilt of the distal radius. When the fibula is transferred to the contralateral wrist, with proper styloid placement, the result is a dorsal tilt of the articular surface.

Lawson<sup>15</sup> transferred an ipsilateral fibula to reconstruct the distal radius after wide resection of the radius. Three months after surgery, the patient had 65° of motion in extension and flexion and was able to return to duty as a police officer. One year after surgery, he was doing well.<sup>15</sup> Yu and colleagues<sup>16</sup> used an ipsilateral fibula to reconstruct an adult's distal radius and reported satisfactory functional recovery 8 years after surgery, with forearm pronation of 80°, supination of 70°, wrist flexion of 35°, and extension of 30°. The patient returned to her previous occupation. Notably, the optimal functional range of motion for most activities of daily living has been found to be 10° of flexion to 35° of extension,<sup>17</sup> thus making the studies described functionally successful. In the case reported by Akinbo and Strauch,<sup>18</sup> the ipsilateral fibula was used because of parental preference, but also since it seemed a better match.

One limitation of our study is the mean age of the cadavers: 85 years. This age group does not allow us to directly apply our findings to the pediatric population. It is in the pediatric population that a fibula transfer for distal radius reconstruction is garnering particular attention because of the potential for continued growth of the transferred proximal fibular physis. It is certainly possible that the thicker cartilage of the proximal fibula in a child, and the potential for remodeling of the pediatric fibular physis over time, could correct discrepancies in volar or dorsal tilt.

Another limitation of our study is that the depth and articular congruity of the proximal fibula facet were not

studied. These parameters may be as important as the radiographic parameters measured in our study; their importance lies in their potential to confer needed stability in osteoarticular reconstruction of the radiocarpal joint after wide excision of the native distal radius. Studies investigating proximal fibula facet depth and articular congruity are needed.

In conclusion, the proximal fibula is similar to the distal radius with respect to coronal and sagittal inclination angles. However, re-creation of native radiographic volar tilt is best achieved by transferring the ipsilateral proximal fibula instead of the contralateral fibula in the adult population.

### AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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*This paper will be judged for the Resident Writer's Award.*

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