

# Editorial Commentary: A Simple Twist of Fate: The Ramifications of Abnormal Femoral Version



Robert L. Buly, M.D., M.S.

**Abstract:** The abnormalities of femoral twist or version, whether increased anteversion or retroversion, are frequently overlooked. These skeletal aberrations are responsible for a host of hip problems such as impingement, instability and damage to the labrum and articular cartilage, often resulting in osteoarthritis if left untreated. In addition to the intrinsic hip damage, extra articular problems such as posterior hip impingement, pelvic tendonopathies, problems with gait and sitting as well as spinal decompensation are also very common. It is incumbent upon those who manage hip problems to be aware of the damage caused by femoral version abnormalities and the treatment options available.

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"A Simple Twist of Fate" is not only one of my favorite songs from Bob Dylan's album "Blood on the Tracks", but it is also a handy metaphor for version problems of the femur. When fate has dealt someone an abnormally twisted femur, either one or both, the consequences can be catastrophic.

As orthopedic surgeons, we have all been trained about the nature of hip dysplasia, and how if left untreated, is the primary cause of hip osteoarthritis. Conditions such as slipped capital femoral epiphysis (SCFE) and Perthes Disease have also long been implicated as arthritis risks as well. However, it is the more subtle anatomic defects that can be more difficult to diagnose and to recognize the damage that they can cause.

While some studies that investigated the etiology of hip osteoarthritis had as many as one-third of cases listed as "idiopathic", additional studies noted the role of proximal femoral deformity.<sup>1-4</sup> The work of Reinhold Ganz and his Swiss colleagues has made us more aware of the concept of hip impingement, especially in its more subtle forms.<sup>5,6</sup> Clohisy feels that fewer than 1% of osteoarthritic hips have an etiology that is "idiopathic", seek, and ye shall find the cause.<sup>7</sup> Studies

documenting the treatment of hip impingement, both open and especially arthroscopic, have markedly increased in number in recent years.<sup>8-10</sup>

Despite earlier studies documenting the hip pain and arthritis associated with version abnormalities, these conditions are still often overlooked.<sup>11-13</sup> A well-known, pioneering hip preservation surgeon once confided to me that, regrettably, he had neglected to assess the impact of femoral version for decades. That helped to explain why a subset of patients would continue to have problems, even after what appeared to be a well-executed operation. If version problems are not recognized and treated, they can be a cause of continued pain after the treatment of dysplasia or hip impingement. Fabricant noted that patients with diminished femoral anteversion have inferior outcome scores after the arthroscopic treatment of hip impingement.<sup>14</sup> Sankar reported that while the femoral version in a series of dysplastic patients averaged 19°, there was an amazing spread of 105°, from 25° of retroversion to 80° of anteversion!<sup>15</sup> It is not hard to imagine what would happen if a total hip stem were to be placed in these extremes of version. Disastrous impingement or instability would occur. In the native hip, structural damage and pain are the results instead. If the femoral anteversion coexisting with dysplasia is extreme, we will usually perform a concomitant femoral derotation osteotomy with the pelvic acetabular osteotomy (PAO), but it is not clear how much anteversion is "too much". However, we feel that with a combined anteversion (femur + acetabulum) of greater than 60°, it can be difficult to achieve success and stability with PAO alone.

Weill Medical College of Cornell University

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How common are these femoral version deformities? They are substantially more common than previously imagined. We use a figure of approximately 15° of femoral anteversion and 5°, 10° and 15° of acetabular version at 1, 2 and 3 o'clock as "normal" version. Ida noted that as many as 40% of dysplastic patients had either cam lesions or diminished femoral anteversion.<sup>16</sup> Dolan reported that 29% of patients with a documented labral tear had either femoral retroversion or increased anteversion.<sup>17</sup> Moya, in a study using 3-dimensional computed tomography scans in patients with hip impingement found that 17% had femoral retroversion and 23% had excessive anteversion.<sup>18</sup> Lerch examined a series of 538 painful hips with either hip impingement or acetabular dysplasia. The femoral version was "abnormal" (less than 10° or greater than 25° of femoral anteversion) in 52%. An astounding 72% with hip pain but no apparent impingement or dysplasia had abnormal femoral version.<sup>19</sup> This highlights the fact that significant hip impingement can occur even in the absence of a cam or pincer lesion. Kraeutler found that femoral retroversion had a greater effect upon hip internal rotation than a cam lesion.<sup>20</sup> I agree with that finding, noting a greater internal rotation improvement following derotation osteotomy than after an arthroscopic osteochondroplasty. Keep in mind that the acetabulum may also be retroverted or excessively anteverted, compounding or offsetting the femoral deformity. It is important to note the combined anteversion, commonly referred to as the McKibben Index, because the version deformities may have an additive or subtractive effect.

While it is understandable that femoral retroversion or increased anteversion can cause labral and chondral damage, it is important to realize that a host of extra-articular problems can also occur. There are those that occur close to the hip joint such as posterior hip impingement,<sup>21</sup> ischiofemoral impingement (IFI),<sup>22</sup> abductor weakness,<sup>23</sup> Hamstring origin tendonopathy<sup>20</sup> and psoas tendonitis.<sup>24</sup> But there are also well documented problems that occur farther away from the hip joint, such as patellofemoral maltracking,<sup>25</sup> core muscle injury (athletic pubalgia)<sup>26</sup> and the spine problems due to hip motion restrictions. As a hip preservation surgeon who also performs hip replacement, I am often amazed at how often patients with untreated back pain can have significant amelioration by restoring normal hip range of motion after arthroplasty. The resolution of arthritic back pain can be a significant bonus once a physiologic hip range of motion is restored.

Compared to the numerous studies reported to treat hip dysplasia and hip impingement, there is a paucity of derotation osteotomy studies in adults with patient reported outcomes. We reported the results of 55 derotation osteotomies in 43 patients, 29% retroverted and

71% excessively anteverted. The modified Harris hip score improved by 29 points ( $p < 0.001$ ).<sup>27</sup> In reviewing the article in this issue, "Femoral Derotation Osteotomy Improves Hip and Spine Function in Patients With Increased or Decreased Femoral Torsion," by authors Hatem, Khoury, Erikson, Jones and Martin,<sup>28</sup> I was thrilled to discover another series of derotation osteotomies done with the same minimally-invasive technique, also with very good results.

Obviously, the goal of femoral derotation is to solve the problem by restoring normal hip range of motion. Their study documented the preoperative range of motion, shown in Table 1 in Hatem et al.<sup>28</sup> Their findings were similar to ours and to the study by Chadayammuri, i.e., retroverted femurs lack internal rotation in flexion and anteverted femurs lack external rotation.<sup>29</sup> It would have been very helpful to have the postoperative range of motion documented as well. Instead, Hatem et al.<sup>28</sup> reported that they were able to normalize hip version by achieving 20-30° of internal rotation for all hips during surgery. They are to be commended for significantly improving not only the Harris hip score but also the spine disability score in the subset of patients in which that was documented. The operation works!

There are some technical features to comment upon. While a derotation femoral osteotomy can be performed open, I also perform all my osteotomies that do not need femoral neck-shaft angle correction (coxa valga or vara) with the same minimally invasive technique. The advantages are a smaller incision, the quadriceps muscles are not disturbed and the osteotomy site is not opened, helping to preserve the blood supply. Because of the inherent stability of the intramedullary nail, weight-bearing as tolerated can be employed instead of the 20% used with plate application. Disadvantages include the diminished surface area contact because the osteotomy is performed further distally when a nail is used instead of a plate. The thick cortical bone at the osteotomy site heals more slowly than the cancellous bone of the proximal or distal femur. Since our series was published, we now save all bone reamings and deliver them to the osteotomy site via the nozzle of a cement gun just prior to inserting the nail. Anecdotally, I have noticed faster healing with improved callus formation using this addition. Another criticism by those hesitant to use this technique is the risk of abductor compromise at the greater trochanter. By using a careful technique and inserting a trochanteric entry nail in the posterior third of the trochanter, we have reported no problems with abductor limp or weakness at follow-up.<sup>27</sup>

I am somewhat puzzled at the method the authors used to confirm the degree of femoral correction: relying upon range of motion assessment alone during surgery. I feel that a more accurate technique is to use

Steinman pins inserted in the femur above and below the osteotomy site in the degree of desired correction. After osteotomy, the pins are kept parallel while the nail is inserted, thus affecting the rotational correction. Once the interlocking screws are placed, the range of motion assessment can now confirm that the degree of correction was proper. There should now be improved internal rotation in retroversion cases and improved external rotation in excessively anteverted cases. With this technique, I have never had to extract the locking screws, readjust and insert screws again. My concern is that with multiple corrections at the distal interlock site, there can be a "shish-kebab effect" that may cause loss of fixation or fracture. Fortunately, the authors did not report this, but they did have a case where the deformity was not corrected, requiring reoperation. Rather than using the "perfect circle" technique for the distal interlocking screw, I prefer employing an electromagnetic probe inside the canal to allow navigation (SureShot, Smith & Nephew, Memphis, TN). I dislike using the "perfect circle" technique unless necessary and would be more annoyed to use it repeatedly if multiple corrections were required. I think the pin above/ pin below technique is safer, faster and more accurate.

The role of hip arthroscopy in the treatment femoral version abnormalities remains unclear. In the study under review, 49% had arthroscopy before the osteotomy, compared to 38% in our study, which were done mostly in an attempt to relieve impingement with an osteochondroplasty. While Hatem et al.<sup>28</sup> did not perform any concomitant hip arthroscopy, we did in 39%. That may be why 32% of patients in the Hatem et al. series required a post-operative arthroscopy compared to only 2% in our study. Anecdotally, our patients seem to do just as well without preoperative or concomitant arthroscopy unless the MRI findings are fairly dramatic. Minimally displaced tears seem to cause no problems if the anatomic deformity is corrected. There does seem to be a role for arthroscopy before the osteotomy if there is a substantial cam lesion and the degree of femoral retroversion is not excessive. It might be possible to "get away with" arthroscopy alone in these cases, with the caveat that osteotomy may be required if painful impingement is still present. Alternatively, cam lesions on femurs that are excessively anteverted may not need to be addressed; there may simply be so much internal rotation present that the cam lesion never impinges upon the acetabulum.

I am surprised that no patients in the reviewed study required hardware removal compared to 73% in our study. I can confirm that patients feel even better in most cases after the hardware has been removed. They are told that the hardware can remain if they are asymptomatic.

With progression of time, we continue to learn more about the subtle hip anatomic variations and the

potential damage that they can cause. Fortunately, version problems of the hip are becoming more widely recognized, but it still amazes me how often they are overlooked, even by seasoned hip preservation surgeons. I have seen many patients treated by hip arthroscopy alone who continue to have pain due to unrecognized version problems. All too often, the patients are told that the "problem was fixed" and it is a mystery why there is still persistent pain. These patients are doubly annoyed when the uncorrected abnormality is explained to them. "Why didn't the other surgeon notice this?" is a common complaint. In the words of Henri-Louis Berson (1859-1941), "The eye sees only what the mind is prepared to comprehend". If you don't think of it, you will miss it. Do your hip patients a favor, please include an assessment of femoral and acetabular version, whether imaging with MRI or 3D CT scans. You may be greatly surprised at the degree of variation encountered. At my institution over the past decade, we routinely include axial slices through the knee to measure femoral version during hip MRI scans. Our 3D CT scans also include an assessment of tibial torsion. In 13% of our anteverted cases, it was necessary to perform a concomitant tibial osteotomy to avoid a marked external foot progression angle in those lacking the classic pigeon-toed gait due to a compensatory external tibial torsion.<sup>27</sup>

In summary, version abnormalities of the femur can be every bit as destructive to the hip joint as dysplasia and the more common types of hip impingement. Unless sought out, these abnormalities can be easily overlooked. Abnormalities of gait and hip range of motion, along with the existence of extra-articular problems and pain, should be a clue that the femoral version is not normal. Fortunately, if the proper diagnosis is made and surgical correction performed, the chances for pain relief, functional improvement and hip survival is high.

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