Improving Functional Recovery After Hip Fracture Surgery

Hans J Kreder MD, MPH, FRCS(C)

February 1, 2009

Improving Functional Recovery After Hip Fracture Surgery

Table of Contents

Immediate Weight Bearing Improves Outcome

It has long been accepted that early mobilization of elderly patients, including those with hip fractures, is critical to avoiding medical problems such as skin, cardiovascular, respiratory and gastrointestinal complications (Koval & Zuckerman, 1997). Moreover immediate weight bearing after hip fracture surgery has been shown to decrease medical complications (Kamel, Iqbal, Mogallapu, Maas & Hoffmann, 2003), decrease mortality (Siu et al., 2006), improve functional recovery (Ammann, 2007; Kamel et al., 2003; Oldmeadow et al., 2006; Portegijs et al., 2008; Sherrington, Lord & Herbert, 2003Sherrington, Lord & Herbert, 2004; Siu et al., 2006), and accelerate discharge from the acute care hospital (Oldmeadow et al., 2006; Rasmussen, Kristensen, Foldager, Myhrmann & Kehlet, 2002).

Immediate Weight Bearing Is Safe

Immediate weight bearing should be applied in all cases after hip fracture surgery to achieve the benefits noted above. In the past, there was concern that early ambulation and weight bearing might lead to implant failure, malunion or nonunion in patients with unstable fracture patterns that had been tenuously fixed. In modern hip fracture care this is no longer an issue for the following reasons:

1. Patients limit the amount of weight placed through the operated limb depending on the stability of the construct (Koval, Sala, Kummer & Zuckerman, 1998), and failure rates are not increased with an immediate weight bearing protocol even in unstable fracture patterns with traditional implants (Koval, Friend, Aharonoff & Zukerman, 1996; Sherrington et al., 2003Sherrington et al., 2004).
2. Modern technology and implants allow for stable fixation, or replacement arthroplasty, in all cases of proximal femur fracture, including those previously considered biomechanically “unstable” after surgery with older implants such as the sliding hip screw (Geiger, Zimmermann-Stenzel, Heisel, Lehner & Daecke, 2007; Haentjens & Lamraski, 2005; Kakar et al., 2007; Kayali, Agus, Ozluk & Sanli, 2006; Parker, 2001; Weise & Schwab, 2001).

There is no longer any reason for hip fracture patients to be subjected to limited weight bearing after hip fracture surgery.

Surgical Strategies

Intracapsular Hip Fractures

Failure rates of surgically fixed intracapsular fractures increases progressively from approximately 6 percent in patients in their 40s to 25 percent in patients over age 70 (Parker, Raghavan & Gurusamy, 2007). Varus malunion and shortening of the femoral neck are associated with inferior functional outcome in all age groups after fixation of intracapsular hip fractures (Zlowodzki et al., 2008). Bone augmentation with calcium phosphate bone substitutes has NOT been shown to improve failure rates for intracapsular fractures (Mattsson & Larsson, 2006). A number of high quality randomized trials have suggested that replacement arthroplasty produces better results than fracture fixation in elderly patients with subcapital hip fractures (Blomfeldt et al., 2007; Frihagen, Nordsletten & Madsen, 2007; Parker & Gurusamy, 2006). Moreover replacement arthroplasty for intracapsular fractures that have failed after primary fixation is less successful than primary arthroplasty (Frihagen et al., 2007). For these reasons, the trend has been for an increasing number of these fractures to be treated with replacement arthroplasty in recent years, especially in elderly patients (Dimon & Laursen, 2008). Whether primary fixation or primary replacement arthroplasty is chosen (both cemented and uncemented), the post operative rehabilitation should involve full weight bearing immediately.

Extracapsular Fractures

Overview

There is considerable variation in the surgical repair of extracapsular hip fractures worldwide (Forte et al., 2008). The literature concerning these injuries must be interpreted with caution as groups of different fracture types are often analysed together, especially in comprehensive literature reviews (Parker & Handoll, 2008). One must consider the specific fracture pattern and location (base of neck, pertrochanteric, reverse obliquity or subtrochanteric) and the degree of metaphyseal comminution (Kregor, Obremskey, Kreder, Swiontkowski & Evidence-Based Orthopaedic Trauma Working Group, 2005). This requires careful preoperative evaluation of the radiographs (Koval, Oh & Egol, 2008) and thoughtful planning of the surgical tactic.

Bone augmentation with calcium phosphate for fractures in the trochanteric region has been shown to decrease hardware failure in biomechanical studies (Elder et al., 2000; Stankewich, Swiontkowski, Tencer, Yetkinler & Poser, 1996; Yetkinler et al., 2002), and has also been associated clinically with less fracture displacement (Mattsson & Larsson, 2004) and with a modest improvement in functional outcome

(Mattsson et al., 2005). In select cases with marked osteopenia, bone augmentation with calcium phosphate substitutes may be considered.

Pertrochanteric Fractures

For pertrochanteric fractures that have a stable lateral cortex and little metaphyseal comminution both extra-medullary devices (such as the sliding hip screw), and intra-medullary devices (cephalomedullary nails) provide reliable union rates and similar failure rates. Given that extramedullary devices tend to be less expensive, they are preferred for fixation of this fracture type (Parker & Handoll, 2008). Good surgical technique, including precise lag screw placement close to the subchondral bone in the centre of the femoral head are key to successful union without implant failure (Baumgaertner & Solberg, 1997).

Reverse Obliquity Fractures

For these injuries an intramedullary device or other alternative should be considered because the sliding hip screw is associated with a very high failure rate (Kregor et al., 2005).

Simple Metaphyseal Pattern

Lack of lateral support in the reverse obliquity fracture pattern often leads to severe shaft medialisation, even if there is little metaphyseal comminution since there is nothing to prevent the proximal fragment from sliding laterally. Medialisation can result in stabilization of the fracture fragments and may result in union, but the resulting malunion can be severe. We have little information regarding the functional consequences of severe malunion in the intertrochanteric region, but extrapolating from information regarding intracapsular fracture malunion would suggest that function is compromised by the shortened femoral neck and overall femoral shortening (Zlowodzki et al., 2008). Intramedullary nailing has become popular in these fracture patterns as a method of preventing shortening and malunion, while still achieving reliable bone healing (Platzer, Thalhammer, Wozasek & Vécsei, 2008). Alternatives include extramedullary devices with a trochanteric side plate to limit shaft medialization or a 95 degree angle device, although the 95 degree devices are also associated with a significant failure rate (Kregor et al., 2005).

Comminuted Metaphyseal Pattern

When there is extensive comminution of the metaphyseal region, the failure rate of standard extramedullary devices, such as the sliding hip screw, is even higher because both shaft medialisation and varus collapse (due to lack of medial support) may occur. Extramedullary devices that allow sliding both along the femoral neck and also axially along the shaft may reduce nonunion and implant failure, but at the expense of shortening of the femoral neck and shaft (Miedel, Ponzer, Törnkvist, Söderqvist & Tidermark, 2005). Intramedullary devices (especially long nails) provide a long working length to avoid stress concentration at the comminuted

fracture site and also minimize shaft medialisation in these fracture types (Parker & Handoll, 2008; Platzer et al., 2008; Stern, 2007). Given the importance of immediate post-operative mobility, the surgeon should select a fixation strategy that makes them feel confident enough in the fixation to allow immediate full weight bearing.

Subtrochanteric Fractures

The key to successful treatment of subtrochanteric fractures is to avoid stress concentration, especially with simple fracture patterns (spiral, short oblique or transverse). Long intramedullary devices provide a long working length (the span between proximal and distal locking screws) by design and thus avoid stress concentration. Plating simple fracture patterns demands one of two strategies:

1. Anatomic reduction of the simple fracture pattern with absolute stability (lag screw and compression plating) techniques.
2. Bridge plating with a long working length (leaving a long span without screw fixation) to avoid stress concentration.

Careful attention to technical detail is essential to avoid varus collapse, nonunion and plate failure. Counter-intuitively, plating of a subtrochanteric fracture with an extensive length of fracture comminution is technically easier as simple submuscular bridge plating techniques can be used to span the comminuted segment (Lee et al., 2007).

Nailing also demands careful attention to detail to avoid malpositioning the proximal fragment relative to the shaft, especially on the lateral view (Jiang, Shen & Dai, 2007; Saarenpää, Heikkinen & Jalovaara, 2007; Shukla et al., 2007). This is because the proximal fragment is often flexed relative to the shaft due to residual muscle attachment of the hip flexors. Nailing in the lateral position with the leg draped free on a radiolucent table often facilitates positioning the distal shaft to match the proximal deformity.

Special Cases

In some cases, the proximal femur is highly fragmented in both the base of neck area and the trochanteric area making it difficult or impossible to avoid malunion, femoral neck shortening, and trochanteric malposition with conventional extramedullary or even intramedullary devices. Use of proximal femoral locking plates can produce anatomic reduction in these fractures but careful attention to detail must be observed to avoid nonunion and ultimately, implant failure. Specifically, care must be taken to achieve compression across the femoral neck fracture to avoid stress concentration in this area. Stress concentration must also be avoided in the metaphyseal region. Because of the difficulty in avoiding complications with fracture fixation in these situations, replacement arthroplasty might be appropriate in select cases (Geiger et al., 2007; Haentjens & Lamraski, 2005; Kayali et al., 2006; Parker & Handoll, 2006; Stern, 2007). Although technically challenging, and associated with a higher risk of morbidity compared with routine total hip arthroplasty, it may provide the best chance of providing immediate

mobility and good function for patients with these difficult fracture patterns (Lyman, Kelley & Lachiewicz, 2004).

Summary

Proximal femoral fractures demand a thoughtful, individualized approach for optimal results to be achieved. Careful pre-operative planning must consider the level of patient demand and comorbidity as well as the specifics of the fracture pattern and associated injuries or pre-existing musculoskeletal problems. A surgical tactic should be chosen that achieves maximal functional results while balancing the risk of implant failure, malunion, and surgical morbidity for the particular patient. Immediate weight bearing for previously ambulatory patients is of paramount importance in minimizing hospital length of stay and patient morbidity and mortality. Immediate weight bearing also maximizes functional outcome and the likelihood of independent living. The surgeon should keep this in mind when formulating a pre-operative plan. Standardized post-operative orders should include "weight bearing as tolerated" routinely.

Bibliography

Ammann, P. (2007). (). *Revue Médicale Suisse*, *3*(115), 1512-4.

Baumgaertner, M. R., & Solberg, B. D. (1997). Awareness of tip-apex distance reduces failure of fixation of trochanteric fractures of the hip. *The Journal of Bone and Joint surgery. British Volume*, *79*(6), 969-71.

Blomfeldt, R., Törnkvist, H., Eriksson, K., Söderqvist, A., Ponzer, S., & Tidermark, J. (2007). A randomised controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in elderly patients. *The Journal of Bone and Joint surgery. British Volume*, *89*(2), 160-5.

Dimon, T. J., & Laursen, J. O. (2008). (). *Ugeskrift for Laeger*, *170*(38), 2949-53.

Elder, S., Frankenburg, E., Goulet, J., Yetkinler, D., Poser, R., & Goldstein, S. (2000). Biomechanical evaluation of calcium phosphate cement-augmented fixation of unstable intertrochanteric fractures. Journal of Orthopaedic Trauma, 14(6), 386-93.

Forte, M. L., Virnig, B. A., Kane, R. L., Durham, S., Bhandari, M., Feldman, R., et al. (2008). Geographic variation in device use for intertrochanteric hip fractures. *The Journal of Bone and Joint surgery. American Volume*, *90*(4), 691-9.

Frihagen, F., Madsen, J. E., Aksnes, E., Bakken, H. N., Maehlum, T., Walløe, A., et al. (2007). Comparison of re-operation rates following primary and secondary hemiarthroplasty of the hip. *Injury*, *38*(7), 815-9.

Frihagen, F., Nordsletten, L., & Madsen, J. E. (2007). Hemiarthroplasty or internal fixation for intracapsular displaced femoral neck fractures: Randomised controlled trial. *BMJ (Clinical Research ed.)*, *335*(7632), 1251-4.

Geiger, F., Zimmermann-Stenzel, M., Heisel, C., Lehner, B., & Daecke, W. (2007). Trochanteric fractures in the elderly: The influence of primary hip arthroplasty on 1-year mortality. *Archives of Orthopaedic and Trauma Surgery*, *127*(10), 959-66.

Haentjens, P., & Lamraski, G. (2005). Endoprosthetic replacement of unstable, comminuted intertrochanteric fracture of the femur in the elderly, osteoporotic patient: A review. *Disability and Rehabilitation*, *27*(18-19), 1167-80.

Jiang, L. S., Shen, L., & Dai, L. Y. (2007). Intramedullary fixation of subtrochanteric fractures with long proximal femoral nail or long gamma nail: Technical notes and preliminary results. *Annals of the Academy of Medicine, Singapore*, *36*(10), 821-6.

Kakar, S., Tornetta, P., Schemitsch, E. H., Swiontkowski, M. F., Koval, K., Hanson, B. P., et al. (2007). Technical considerations in the operative management of femoral neck fractures in elderly patients: A multinational survey. *The Journal of Trauma*, *63*(3), 641-6.

Kamel, H. K., Iqbal, M. A., Mogallapu, R., Maas, D., & Hoffmann, R. G. (2003). Time to ambulation after hip fracture surgery: Relation to hospitalization outcomes. *The Journals of gerontology. Series A, Biological Sciences and Medical Sciences*, *58*(11), 1042-5.

Kayali, C., Agus, H., Ozluk, S., & Sanli, C. (2006). Treatment for unstable intertrochanteric fractures in elderly patients: Internal fixation versus cone hemiarthroplasty. *Journal of Orthopaedic Surgery (Hong Kong)*, *14*(3), 240-4.

Koval, K. J., & Zuckerman, J. D. (1997). Orthopaedic challenges in the aging population: Trauma treatment and related clinical issues. *Instructional Course Lectures*, *46*, 423-30.

Koval, K. J., Friend, K. D., Aharonoff, G. B., & Zukerman, J. D. (1996). Weight bearing after hip fracture: A prospective series of 596 geriatric hip fracture patients. *Journal of Orthopaedic Trauma*, *10*(8), 526-30.

Koval, K. J., Oh, C. K., & Egol, K. A. (2008). Does a traction-internal rotation radiograph help to better evaluate fractures of the proximal femur?. *Bulletin of the NYU Hospital for Joint Diseases*, *66*(2), 102-6.

Koval, K. J., Sala, D. A., Kummer, F. J., & Zuckerman, J. D. (1998). Postoperative weight-bearing after a fracture of the femoral neck or an intertrochanteric fracture. *The Journal of Bone and Joint surgery. American Volume*, *80*(3), 352-6.

Kregor, P. J., Obremskey, W. T., Kreder, H. J., Swiontkowski, M. F., & Evidence-Based Orthopaedic Trauma Working Group (2005). Unstable pertrochanteric femoral fractures. *Journal of Orthopaedic Trauma*, *19*(1), 63-6.

Lee, P. C., Hsieh, P. H., Yu, S. W., Shiao, C. W., Kao, H. K., & Wu, C. C. (2007). Biologic plating versus intramedullary nailing for comminuted subtrochanteric fractures in young adults: A prospective, randomized study of 66 cases. *The Journal of Trauma*, *63*(6), 1283-91.

Lyman, J. R., Kelley, S. S., & Lachiewicz, P. F. (2004). Hip arthroplasty after extracapsular hip fracture: A matched pair cohort analysis. *Journal of Surgical Orthopaedic Advances*, *13*(1), 38-41.

Mattsson, P., & Larsson, S. (2004). Unstable trochanteric fractures augmented with calcium phosphate cement. A prospective randomized study using radiostereometry to measure fracture stability. Scandinavian Journal of Surgery : SJS : Official Organ for the Finnish Surgical Society and the Scandinavian Surgical Society, 93(3), 223-8.

Mattsson, P., & Larsson, S. (2006). Calcium phosphate cement for augmentation did not improve results after internal fixation of displaced femoral neck

fractures: A randomized study of 118 patients. Acta Orthopaedica, 77(2), 251-6.

Mattsson, P., Alberts, A., Dahlberg, G., Sohlman, M., Hyldahl, H. C., & Larsson, S. (2005). Resorbable cement for the augmentation of internally-fixed unstable trochanteric fractures. A prospective, randomised multicentre study. The Journal of Bone and Joint surgery. British Volume, 87(9), 1203-9.

Miedel, R., Ponzer, S., Törnkvist, H., Söderqvist, A., & Tidermark, J. (2005). The standard gamma nail or the medoff sliding plate for unstable trochanteric and subtrochanteric fractures. A randomised, controlled trial. *The Journal of Bone and Joint surgery. British Volume*, *87*(1), 68-75.

Oldmeadow, L. B., Edwards, E. R., Kimmel, L. A., Kipen, E., Robertson, V. J., & Bailey, M. J. (2006). No rest for the wounded: Early ambulation after hip surgery accelerates recovery. *ANZ Journal of Surgery*, *76*(7), 607-11.

Parker, M. J. (2001). Current concepts in the treatment of hip fracture. *Zeitschrift Für Gerontologie Und Geriatrie : Organ Der Deutschen Gesellschaft Für Gerontologie Und Geriatrie*, *34*(1), 74-7.

Parker, M. J., & Gurusamy, K. (2006). Internal fixation versus arthroplasty for intracapsular proximal femoral fractures in adults. *Cochrane Database of Systematic Reviews (Online)*, (4), CD001708.

Parker, M. J., & Handoll, H. H. (2006). Replacement arthroplasty versus internal fixation for extracapsular hip fractures in adults. *Cochrane Database of Systematic Reviews (Online)*, (2), CD000086.

Parker, M. J., & Handoll, H. H. (2008). Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. *Cochrane Database of Systematic Reviews (Online)*, (3), CD000093.

Parker, M. J., Raghavan, R., & Gurusamy, K. (2007). Incidence of fracture-healing complications after femoral neck fractures. *Clinical Orthopaedics and Related Research*, *458*, 175-9.

Platzer, P., Thalhammer, G., Wozasek, G. E., & Vécsei, V. (2008). Femoral shortening after surgical treatment of trochanteric fractures in nongeriatric patients. *The Journal of Trauma*, *64*(4), 982-9.

Portegijs, E., Kallinen, M., Rantanen, T., Heinonen, A., Sihvonen, S., Alen, M., et al. (2008). Effects of resistance training on lower-extremity impairments in older people with hip fracture. *Archives of Physical Medicine and Rehabilitation*, *89*(9), 1667-74.

Rasmussen, S., Kristensen, B. B., Foldager, S., Myhrmann, L., & Kehlet, H. (2002). (). *Ugeskrift for Laeger*, *165*(1), 29-33.

Saarenpää, I., Heikkinen, T., & Jalovaara, P. (2007). Treatment of subtrochanteric fractures. A comparison of the gamma nail and the dynamic hip screw: Short-Term outcome in 58 patients. *International Orthopaedics*, *31*(1), 65-70.

Sherrington, C., Lord, S. R., & Herbert, R. D. (2003). A randomised trial of weight-bearing versus non-weight-bearing exercise for improving physical ability in inpatients after hip fracture. *The Australian Journal of Physiotherapy*, *49*(1), 15-22.

Sherrington, C., Lord, S. R., & Herbert, R. D. (2004). A randomized controlled trial of weight-bearing versus non-weight-bearing exercise for improving physical ability after usual care for hip fracture. *Archives of Physical Medicine and Rehabilitation*, *85*(5), 710-6.

Shukla, S., Johnston, P., Ahmad, M. A., Wynn-Jones, H., Patel, A. D., & Walton, N. P. (2007). Outcome of traumatic subtrochanteric femoral fractures fixed using cephalo-medullary nails. *Injury*, *38*(11), 1286-93.

Siu, A. L., Penrod, J. D., Boockvar, K. S., Koval, K., Strauss, E., & Morrison, R. S. (2006). Early ambulation after hip fracture: Effects on function and mortality. *Archives of Internal Medicine*, *166*(7), 766-71.

Stankewich, C. J., Swiontkowski, M. F., Tencer, A. F., Yetkinler, D. N., & Poser, R. D. (1996). Augmentation of femoral neck fracture fixation with an injectable calcium-phosphate bone mineral cement. Journal of Orthopaedic Research : Official Publication of the Orthopaedic Research Society, 14(5), 786-93.

Stern, R. (2007). Are there advances in the treatment of extracapsular hip fractures in the elderly?. *Injury*, *38 Suppl 3*, S77-87.

Weise, K., & Schwab, E. (2001). (). *Der Chirurg; Zeitschrift Für Alle Gebiete Der Operativen Medizen*, *72*(11), 1277-82.

Yetkinler, D. N., Goodman, S. B., Reindel, E. S., Carter, D., Poser, R. D., & Constantz, B. R. (2002). Mechanical evaluation of a carbonated apatite cement in the fixation of unstable intertrochanteric fractures. Acta Orthopaedica Scandinavica, 73(2), 157-64.

Zlowodzki, M., Brink, O., Switzer, J., Wingerter, S., Woodall, J., Petrisor, B. A., et al. (2008). The effect of shortening and varus collapse of the femoral neck on function after fixation of intracapsular fracture of the hip: A multi-centre cohort study. *The Journal of Bone and Joint surgery. British Volume*, *90*(11), 1487-94.