Abstract

Skeletal traction (Perkin's traction) is the most common form of femoral fracture fixation in the developing world (Bezabeh and Wamisho, 2010, Opondo et al., 2013, Sekimpi et al., 2011), with pin tract infection occurring in 42.6% of cases, while the patient remains bed ridden for seven weeks (Gosselin and Lavaly, 2007). First world femoral fracture fixation methods such as interlocking intramedullary nails are available in the developing world, however they are not affordable for a large majority of citizens who earn the minimal wage of $0.35 AUD per day (Besamusca et al., 2012), and are not customisable for the patient. This requires a low cost, customisable femoral fracture fixation method, with the scope of this project focusing on 0°-30° transverse femoral shaft fractures.

Femoral fracture fixation methods were reviewed and analysed to determine the best method to form the basis of the low cost, customisable fracture fixation method. Flexible intramedullary nails performed as well as interlocking intramedullary nails and better than skeletal traction in the range of knee joint mobility and complications, with a slightly longer time to full weight bearing compared to interlocking intramedullary nails. Flexible intramedullary nailing had the easiest manufacturing process as each nail is formed from single, solid rods of 316L stainless steel.

The low cost flexible intramedullary nails were designed to be easily customisable in regards to length and curvature, as well as being manufactured using readily available tools. The stainless steel rods can be cut using a tube cutter, while the bent tip of the nail can be formed using pliers to bend the nail over a stainless steel offcut. The nails can then be bent by hand by the surgeon to align the apex of the curve to the fracture site on the femur. The stainless steel costs between $1.80 - $4.90 AUD per meter, with the tooling provided by a single initial cost of $78.88, providing a low cost fracture fixation alternative.

Finite element analysis was performed to compare the stiffness of the low cost flexible intramedullary nails to a perfectly and imperfectly fitted interlocking intramedullary nail using a 4-point bend test, with the aim of the flexible intramedullary nails being at least 50% as stiff as the interlocking intramedullary nails. This is important as the stiffness of the nail

determines the stability it provides to the fracture, and, in association with callus formation at the fracture, determines when partial and full weight bearing can occur. The results showed that the flexible intramedullary nails produced a maximum of 32% of the stiffness of an imperfectly fitted interlocking intramedullary nail, which is below the desired stiffness.

Further investigations are recommended to determine the validity of the finite element analysis results should be conducted as simple models were used rather than complex, anatomically correct models for the flexible intramedullary nail and the femoral shaft. This will help determine if the flexible intramedullary nails can provide adequate stability to the fracture, and if further studies such as surgeon surveys, plastic and cadaver simulations, kit production, and clinical trials should be conducted.