Injury, Int. J. Care Injured 42 (2011) S3–S15

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Complications following autologous bone graft harvesting from the iliac crest and using the RIA: A systematic review

Rozalia Dimitriou [a], George I. Mataliotakis [a], Antonios G. Angoules [a], Nikolaos K. Kanakaris [a], Peter V. Giannoudis [b,*]

[a] Department of Trauma and Orthopaedic Surgery, Leeds Teaching Hospitals NHS Trust, Leeds, UK
[b] Academic Department of Trauma and Orthopaedics, School of Medicine, University of Leeds, Leeds General Infirmary, Clarendon wing Level A, Great George Street, LS1 3EX Leeds, UK

ARTICLE INFO

Keywords:
Autologous bone graft
Iliac crest
RIA
Complications
Morbidity
Systematic review

ABSTRACT

Bone grafting is a commonly performed surgical procedure to augment bone regeneration in a variety of cases in orthopaedic and maxillofacial surgery. Autologous bone graft remains to be the 'gold standard' and the iliac crest to be the most common harvesting site. The intramedullary canal of long bones represents another potential site for large volume of autologous bone graft harvesting and is recently being used as an alternative donor site. However, harvesting of autologous bone graft is associated with morbidity and a number of complications. The aim of this systematic review was to collect and summarise the existing data on reported complications after harvesting autologous bone from the iliac crest (anterior and posterior) and the long bone intramedullary canal using the RIA device. We searched the PubMed Medline and Ovid Medline databases, from January 1990 to October 2010, to retrieve all relevant articles. A total of 92 articles (6682 patients) were included in the analysis. Overall, the complication rate following RIA was 6% (14 complications in 233 patients) and 19.37% after iliac crest bone graft harvesting (1249 complications in 6449 patients). The rate of each of the reported complications was assessed and, when the donor site was properly documented, comparison within the anterior and posterior iliac crest donor sites was performed. Although the difference of the overall morbidity rates between the two harvesting sites was not statistically significant ($p = 0.71$); the rates of certain complications were found to significantly differ when anterior or posterior iliac crest was used. The rates of infection ($p = 0.016$), haematoma formation ($p = 0.002$), fracture ($p = 0.017$), and hyperthrophic scar ($p = 0.017$) were significantly higher when the donor site was the anterior iliac crest compared to the posterior iliac crest; whereas the rates of chronic donor site pain ($p = 0.004$) and sensory disturbances ($p = 0.003$) were significantly lower. The incidence of bone graft harvesting related complications can be reduced further if certain principles are followed depending on the performed harvesting methods; but overall the use of RIA device as harvesting method seems a promising alternative with a low complication rate.

Introduction

Autologous bone is considered to be the "gold standard" bone grafting material as it combines all properties required in a bone graft material: osteoinduction (BMPs and other growth factors), osteogenesis (osteoprogenitor cells) and osteoconduction (scaffold).[1] It is widely used in a number of orthopaedic and oral and maxillofacial procedures for augmentation and acceleration of bone regeneration (fusion, non-union, fracture and osteotomy healing) or restoration of bony defects (traumatic, congenital, following tumour or infection). Harvested from the patient itself, autologous bone is histocompatible and nonimmunogenic, thus reducing to the minimum immunoreactions and transmission of infections.

Iliac crest bone graft (ICBG) is by far the most commonly used autologous bone graft compared to other alternative donor sites, such as the proximal tibia, distal femur, fibula, ribs and distal radius. It can be harvested from the anterior or the posterior iliac crest. Its main advantages include the availability of a fair bone quantity of bone graft (cancellous, cortico-cancellous or vascularised) with progenitor cells and growth factors, and structural support when tricortical graft is used.[1,2] Although iliac crest bone harvesting is a frequently performed surgical procedure with relatively easy access, its complications have been well documented in the literature with a wide range of morbidity rate and a number of various complications, including

* Corresponding author. Tel.: +44 (0) 113 392 2750; fax: +44 (0) 113 392 3290.
E-mail address: pgiannoudi@aol.com (P.V. Giannoudis).

0020–1383/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.injury.2011.06.015

infection, haematoma/seroma, fracture, nerve and vascular injuries, chronic donor site pain, hernias, unsightly scars and poor cosmetic outcome.[3,4]The intramedullary canal of long bones represents another potential donor site for autologous bone graft and a rich source of cells and growth factors.[2,5,6] A relatively new device, the Reamer/Irrigator/Aspirator system (RIA) (Synthes Inc., West Chester, PA) although initially developed to simultaneous ream and aspirate the reaming debris to reduce the intramedullary pressure, heat generation and systemic effects seen during the traditional reaming process,[7–9] it has been recently used to harvest bone graft from the intramedullary canal of the femur or the tibia. It provides larger volumes of autologous graft (25–90 cm^3) compared to anterior ICBG (5–72 cm^3); at least similar volumes when compared to posterior ICBG (25–88 cm^3) and in younger individuals it may provide even larger volumes than posterior ICBG. It has been reported to have minimal complications, less pain post-harvesting and possibly a shorter harvest time compared to anterior and posterior ICBG harvesting.[10] However, complications following RIA intramedullary harvesting such as cortical perforation and fracture have also been reported within the few articles published regarding this technique.[10–14]

The aim of this systematic review was to collect and summarise the existing data on reported complications after harvesting autologous bone from the iliac crest (anterior and posterior) as well as from the intramedullary canal using the RIA device, in an effort to evaluate their overall reported complication rates and assess whether there is a difference in their morbidity as bone harvesting methods. By over viewing the recent literature, recommendations are made aiming to reduce morbidity from these harvesting procedures. An effort to assess the impact of ICBG harvesting in length of hospital stay (LOS) in non-orthopaedic procedures was also undertaken.

Methods

Literature search

We searched the PubMed Medline and Ovid Medline databases, from January 1990 to October 2010, to retrieve all relevant articles reporting on the clinical use of the RIA device and on the use of iliac crest (anterior and posterior) as a harvesting site for autologous bone graft for a number of orthopaedic, oral and maxillofacial procedures. The bibliographies of identified articles were manually searched, as well as the ''related articles'' options in PubMed Medline. The search was restricted to studies published in English.

Criteria for eligibility

For the RIA device, since it represents a relatively new method for reaming, for autologous bone harvesting and for other potential applications such as osteomyelitis, all clinical studies referred to its use were reviewed. Therefore, all case series and case reports for other indications than bone harvesting were also included in the analysis.

For the autologous iliac crest bone graft, studies selected were original articles fulfilling the following eligibility criteria: (1) inclusion of more than 10 patients; (2) articles were published in English; (3) the full text of each article was available; (4) cancellous, cortico-cancellous, bi-cortical or tri-cortical autologous bone graft was harvested from the anterior or the posterior iliac crest; (5) complications from the donor site were documented (major/minor or not classified); (6) a minimum mean or median of 6 months follow-up was reported. All articles that did not meet the above criteria were excluded, including reviews and case reports.

Extraction of data

All relevant information on publication year, authors' names, numbers of patients, bone graft harvesting site and method if reported, initial procedure requiring bone grafting, duration of follow-up, and all documented complications from the donor site were carefully extracted and computerised. For the analysis, no classification into minor and major or acute and chronic complications was made, because these differ within the different studies. For the RIA harvesting method, additionally the incidence of anterior cortex violation and any other adverse events were documented and included in the analysis. Finally, the LOS was recorded, when available.

Statistical analysis

Statistical analysis was only performed to compare the complications rates between anterior and posterior ICBG harvesting, using Chi-square test. A p value of 0.05 or less was consider as statistical significant.

Results

Literature search

After the initial electronic search, 157 articles were yielded as potentially eligible, based on the title and the abstract. After obtaining the full text, a total of 92 articles were found to fulfil the inclusion criteria.[3,11–101] The majority of studies were retrospective case series.

RIA

Twelve studies with a total number of 233 patients were found to use the RIA device as graft harvesting technique or as irrigation and debridement method for osteomyelitis of the femur or the tibia (Table 1).[11–22] Autologous bone was harvested for a number of procedures including long-bone non-unions and complex fractures, segmental bone defects, spine fusion, ankle and knee fusion, congenital pseudarthrosis, docking site after lengthening and deformity correction[11–15,17–20] as well as mandibular reconstruction for tumour (ameloblastoma).[16] A total of 14 complications were documented and these included four fractures,[11] four cases of penetration of the anterior cortex,[11,14,17] one violation of the knee joint[14] and one case of aggressive reaming of the neck, which underwent prophylactic osteosynthesis.[17] Two cases of asymptomatic heterotopic ossification near the abductor insertion (Brooker 1)[12] and one hypertrophic scar were reported.[18] Finally, there was one episode of intraoperative bradycardia and hypotension after prolonged use of RIA in an effort to dislodge the reamer.[14] There were no vascular or nerve injuries and no infection or haematoma formation. The overall complication rate was 6%.

ICBG

Eighty-one studies met our inclusion criteria with 6449 total number of patients and 1249 donor site reported complications, with an overall morbidity rate of 19.37% (Table 2).[3,17,23–101] There were 91 reported cases of infection,[17,24,31,32,41,42,44,45,51,55,56,59,63,64,66–68,70,72–74,76,78,81,82,85–87,89,90,93,95,97–99,101] 24 of which were documented as deep and were treated by irrigation, debridement and proper antibiotic administration. From a total of 96 postoperative haematomas,[3,17,25,27,36,37,39,42,43,60,63,64,70,72,81,84,85,87,88,92,93,96,97,99] 15 were documented to be treated operatively and from 41 seromas,[45,52,60,63,64,70,91–93,95,101] six were aspirated. There were