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Comprehensive analysis of the volume of bone for grafting that can be harvested from iliac crest donor sites

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Abstract

Our aim was to calculate the volumes of cancellous, cortical, and corticocancellous bone that can be harvested as a graft from the anterior and posterior iliac crests using 3-dimensional computed tomography (CT) and software in a living adult population. We selected random CT scans of the pelvis from 31 men and 29 women from the Department of Radiology imaging database. CT data in DICOM file format were imported into Mimics software. The anterior iliac crest and posterior iliac crest bone graft-harvested boundaries were measured. The volume of the 3-dimensional cortical and cancellous bone grafts was measured using the Mimics software. There were significant differences in all comparisons between the anterior and posterior iliac crest, except for volumes of cortical bone. More cancellous and total corticocancellous bone can be harvested from the posterior than the anterior iliac crest, together with similar or smaller volumes of cortical bone. Sex, but not age, is an important factor in terms of the amount of bone that can be harvested, with a wide range of volumes individually from both iliac crests.

Keywords: Anterior iliac crest; Posterior iliac crest; Autogenous bone Graft; Bone graft volume

Introduction

The iliac bone is one of the most commonly-used extraoral donor sites for the harvest of both cortical and cancellous bone grafts for reconstructive operations,[1] and the two approaches include the anterior and posterior iliac crests.[2] The amount of bony tissue that can be harvested from these donor sites is one of the most important factors that affect the choice of reconstruction and the selection of the donor site.

The amount of bone graft that it is possible to harvest from the iliac crests has been the subject of various investigations,[3–8] and although these studies provided important information, there were some limitations such as diversity in the methods and anatomical landmarks used, variable estimates of volume among studies, limited number of samples in some studies, and the use of cadavers. There is also a need to clarify the amount of cortical, cancellous, and corticocancellous bone that can be harvested from the iliac crests.

Excellent measurements of dimensions and volume can now be made of the bone structure using computed tomography (CT) of living patients together with 3-dimensional imaging and software.[9,10] The aim of this study was therefore

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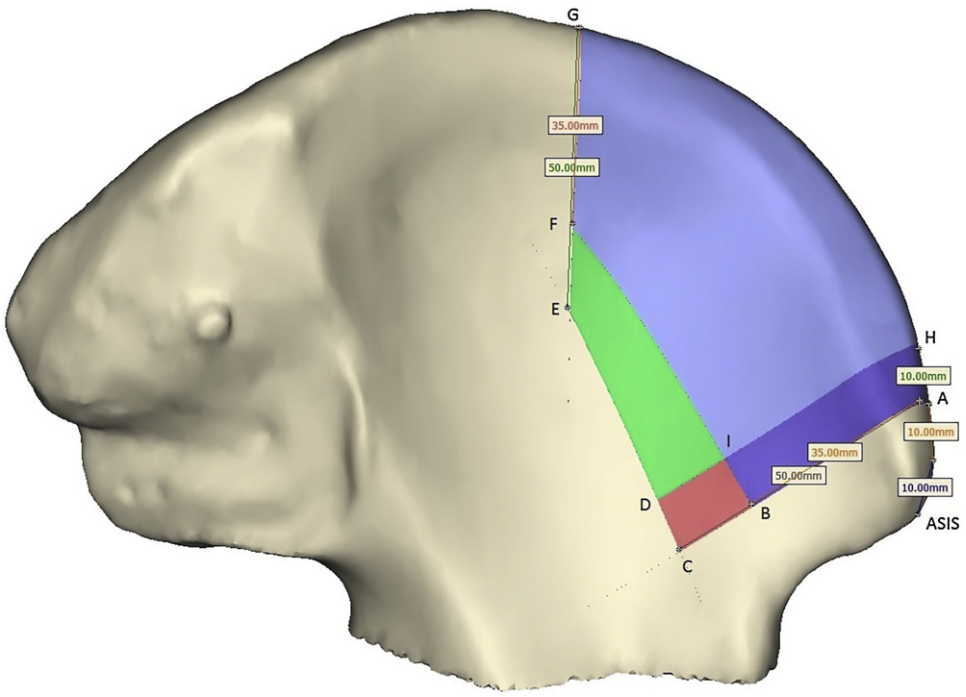

The area between the A, C, E, and G points shows the borders of the harvested bone graft in the anterior iliac crest-1. The area between the A, B, F, and G points shows the borders of the harvested bone graft in the anterior iliac crest-2. The area between the H, D, E, and G points shows the borders of the harvested bone graft in the anterior iliac crest-3. The area between the H, I, F, and G points shows the borders of the harvested bone graft in the -4. ASIS = anterior superior iliac spine.

to calculate the volumes of cancellous, cortical, and corticocancellous bone that can be harvested for grafting from the anterior and posterior iliac crests using 3-dimensional CT and software in a large living adult population, while taking into account the reference points for the safe harvesting of bone reported in various studies.

Patients, material, and methods

Computed tomographic scans of the pelvis were randomly selected from the Erzurum University Faculty of Medicine, Department of Radiology imaging database. The selected scans met the following criteria: no present or previous trauma; no history of harvesting bone; no signs of disease, total hip replacement, previous operations on either iliac crest with intact screws or plates; and no condition that could interfere with the measurement of the size or the volume.

Scans with slices 0.3–0.5 mm thick were obtained, and the CT data were imported in DICOM file format into Mimics software (Materialise, Leuven, Belgium).

Using this software, a mask was created first for the cortical part of the pelvis. Individualised values for the limit of the number of Hounsfield Units (HU) of this mask were obtained. The errors were corrected in accordance with the gray value of the radiological sections, the cancellous bone mask was then created in accordance with the specific HU values, and the bone models were completed. The gray values enabled the margins of cancellous and cortical bone to be calculated.

The boundaries for harvesting bone from the anterior and posterior iliac crests were calculated using the Mimics measurement menu on the models obtained. The bone graft from the anterior iliac crest was designed in accordance with the medial approach, and the anatomical landmarks and boundaries were used as landmarks as well, which were adapted from the study by Burk et al.[3]

These boundaries indicate the widest limits, and have been narrowed in accordance with the recommendations reported in several studies;[11–13] four different measurements have been made. The landmarks were as follows:

The first (AIC-1) - the anterior border was located 2 cm posterior to the anterior superior iliac spine to prevent fracture of the iliac crest and spine and to avoid damage to the lateral femoral cutaneous nerve during the incision. The posterior border was the distance at which the ilium narrowed and became monocortical by the anatomical limitations of each sample. The inferior border was 5 cm long.

The second (AIC-2) - the anterior and posterior borders were similar to those in AIC-1. The inferior border was 3.5 cm long. Ropars et al[13] recommended 35 mm as a useful height for the graft, and Murata et al[12] reported that the risk of injuries to the lateral femoral cutaneous nerve increased when grafts more than 30 mm long were harvested.

The third (AIC-3) - the anterior border was located 3 cm posterior to the anterior superior iliac spine. This distance was recommended by Hu et al to prevent fracture of the iliac crest.[11] The posterior and inferior borders were similar to those in AIC-1.