Archives of Orthopaedic and Trauma Surgery (2019) 139:423–428
https://doi.org/10.1007/s00402-018-3098-3

HANDSURGERY

Donor site complications following anterior iliac crest bone graft for treatment of distal radius fractures

Arnold J. Suda[1] · Christian T. Schamberger[2] · Tim Viergutz[3]

Received: 26 November 2018 / Published online: 12 December 2018

Abstract

Introduction In distal radius fractures with metaphyseal comminution, bone grafting or the use of a bone substitute may be necessary. Harvesting autologous iliac crest bone graft for other orthopedic procedures has complications. The aim of this study was to evaluate the complication rate after harvesting a small amount of bone as used for the treatment of radius fractures.

Patients and methods Patients treated in a single level I trauma center with surgical treatment for distal radius fracture with iliac crest bone graft between January 2008 and December 2012 were included in this retrospective study. Patients' records were evaluated and clinical evaluation was performed at follow-up.

Results 42 patients (20 females, 22 males, mean age 56.3 ± 15.9 years) were included in this study. Follow-up was mean 6.3 ± 1.2 years. Only minor complications such as hematoma could be identified; in one patient, revision surgery for bleeding was performed. No nerve injuries, long-term pain, fractures, infections or wound healing disturbances could be seen. The use of a drain of hemostyptics, the type of wound closure or pattern of harvested bone did not influence complication rate.

Conclusion This study shows that harvesting a small amount of iliac crest bone graft for the treatment of distal radius fractures is a safe procedure with a very low complication rate.

Keywords Distal radius fracture · Iliac crest bone graft · Donor site morbidity · Complications

Introduction

Autologous bone grafting is a long-established method, first performed on soldiers after war wounds in the seventeenth century [5, 6, 15, 26, 32]. This changed to bone defect and non-union treatment [35] and is now equivalent to allograft bone or bone substitutes [11]. Harvesting from anterior iliac crest has the advantage of access in supine position or beach chair position. A disadvantage is the higher complication rate compared to posterior iliac crest bone harvesting [1] but overall, the rates are moderate to low. The most common complications are infections, hematoma/bleedings, and sensory disturbances of the lateral femoral cutaneous nerve. Fractures or severe complications are rare [3, 18, 30]. Distal radius fracture is the most frequent fracture in humans [8, 21, 23]. The AO classification is mostly used to describe fracture pattern, and gives hints for treatment decision-making [27]. In fracture treatment, correct restoration of joint anatomy and bone length including bone losses should be achieved, regardless of the used implant or technique [10, 12, 14, 25, 36].

In this study, all fractures showed a metaphyseal defect after fracture. After proper reduction, the dorsal comminution zone does not provide a stable bony wall. Bone grafting or use of bone substitute was indicated. An autologous bone graft is osteogenetic, osteoinductive and osteoconductive and superior to allograft or bone substitutes. However, harvesting has complications, as mentioned before [17].

✉ Arnold J. Suda
arnoldsuda@yahoo.com

[1] Department of Orthopaedics and Trauma Surgery, University Medical Center Mannheim, Medical Faculty Mannheim of Heidelberg University, Theodor-Kutzer-Ufer 1-3, 68167 Mannheim, Germany

[2] Department of Trauma and Orthopedic Surgery, BG Trauma Center Ludwigshafen, Ludwig-Guttmann-Strasse 13, 67071 Ludwigshafen, Germany

[3] Department of Anesthesiology and Operative Intensive Care, University Medical Center Mannheim, Medical Faculty Mannheim of Heidelberg University, Theodor-Kutzer-Ufer 1-3, 68167 Mannheim, Germany

The aim of this study was to evaluate the donor site morbidity following anterior iliac crest harvesting for autograft in the treatment of distal radius fractures and to identify potential risk factors for complications. Unlike other localizations, only a small amount of bone graft is needed for the treatment of distal radius fractures. It could, therefore, be cheaper than the use of allograft bone or bone substitutes, and in view of this economic impact the results of this study might lead to a re-assessment of how distal radius fractures are treated.

Patients and methods

Patients with acute distal radius fracture who received an open reduction and fixation with locking plate and additional autograft bone transplantation from the anterior iliac crest between January 2008 and December 2012 were included in this study. Non-union therapy or late bone grafting were exclusion criteria. Patient's demographic and clinical data, co-morbidities, fracture classification, duration of hospital admission, and complications as documented in patients' records (revision surgery, nerve injuries, fractures, hematoma, bleeding, wound healing disturbances, infections, pain, etc.) were evaluated from the patient's records.

Harvesting of the iliac crest bone was performed using an incision starting minimum 3 cm dorsal of the spina iliaca anterior superior along the iliac crest and exposure of the bone (Figs. 1, 2). Cortical bone, cancellous bone or chips were removed using an oscilliating saw, a curved osteotome or spoons (Fig. 3). The wound was irrigated and bleedings were stopped with or without the use of hemostatics. The fascia was closed and a subcutaneous drain was placed. The skin was closed with stitches and infiltration with 10 ml Bupivacaine 0.5% was applied. Every step described including the surgeon's experience and duration of surgery was evaluated as a risk factor for complications.

Complications were classified as intra- and postoperative major or minor complications. These included revision surgery, fractures, bleeding, nerve lesions, pain, hematoma, infection, wound healing disturbances, delayed discharge or death. At last follow-up, a re-evaluation of all parameters, including risk factors such as co-morbidities, drugs, alcohol and smoking, was performed.

Statistical analysis and descriptive statistics were performed using Microsoft® Excel® Vers. 14.1.0 and SPSS 22.0 (IBM, Armonk, USA). A power analysis showed 31 patients as a cut-off point for statistical significance regarding H_0- (no increased risk of complications compared to literature) and H_1-hypothesis. Chi-squared test, Student's t test and Mann–Whitney U test were used. $p < 0.05$ was defined as statistically significant.

The local and institutional ethics committee approved this study.

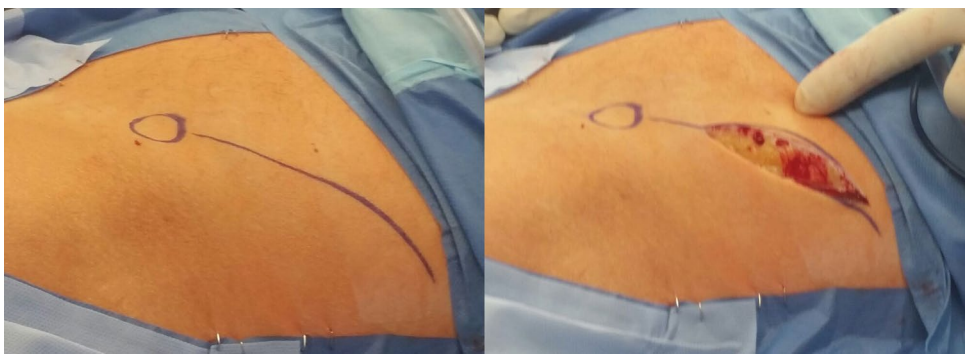

Fig. 1 Landmarks and skin incision on anterior iliac crest

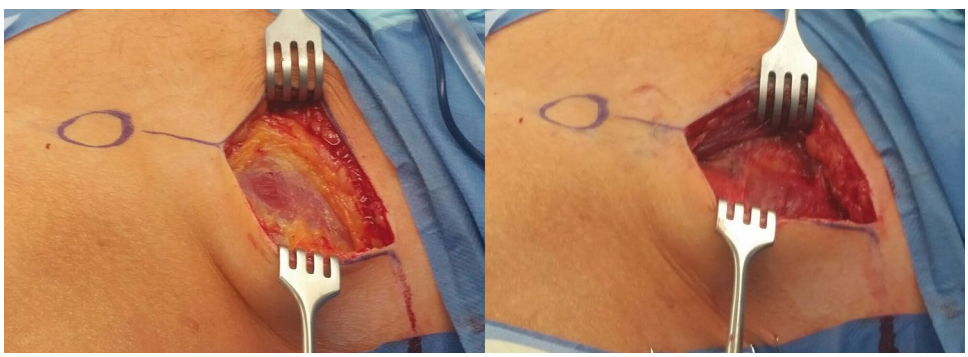

Fig. 2 Incision to and through fascia with exposed iliac crest

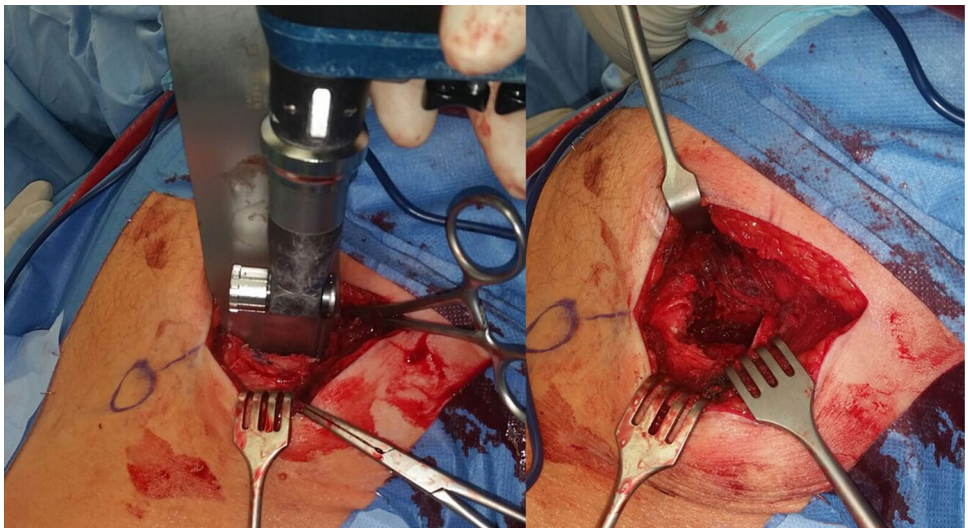

Fig. 3 Harvesting of a bone block using a saw. Iliac crest after harvesting

Results

136 patients were identified, and 42 (22 females, 20 males) of them fitted the inclusion criteria. Mean follow-up was 75 months (6.3 years; range 4.7–8.6 years). Mean age was 56.3 years (range 19–81). 8 patients were between 19 and 40 years old, 17 patients were between 41 and 60 years old. 17 patients (40.5%) had normal BMI; 13 (32%) were above normal. There were 22 patients (52.4%) with left and 20 patients (47.6%) with right radius fractures. Bone graft was harvested from the same side in 41 (97.6%) of cases. 31 patients (73.8%) had type C3 fractures of the radius, 7 (16.7%) showed type C2, and 4 (9.5%) an A3-type fracture. Mean hospital admission was 12.3 days (range 4–27) due to multiple trauma and revision surgery in one case. Four patients (9.5%) suffered from pain at the iliac crest. 26 patients (61.9%) showed hematoma in the first post-operative day, but at discharge, the hematoma was almost resolved in all cases. No nerve injuries, wound healing disturbances, fractures, deaths or infections were seen. One patient (2.4%) had relevant bleeding and underwent revision surgery twice. There was no relationship between the surgeon's experience and complications. Mean duration of procedure was 71 min (range 34–270) including multiple injury treatment. In 32 patients (76.2%), cancellous bone (15 patients), bone chips or a small block was harvested. In ten patients (23.8%), a combination of the techniques was performed. Documented hemostasis was performed in 13 patients (31%), in 38 patients (90.5%) a hemostyptic agent and in 39 patients (93%) a drain was placed. In 24 patients, (57.1%) irrigation and application of local anesthesia were performed. Six patients (14.3) % were treated with NOAKs or aspirin pre-operatively. 35 of them (83.3%) developed hematomas, whereas 21 (58.3%) of the 36 patients without the use of NOAKS or aspirin showed hematoma that was not statistically significant ($p = 0.24\%$). One patient took immunosuppressive medication.

The cohort was relatively healthy: ten patients (23.8%) had arterial hypertony, only one had peripheral arterial disease, another one cardiac insufficiency. Five patients (11.9%) had diabetes, four (9.52%) had osteoporosis. Seven patients (17%) had allergies (two of them drug-associated allergies). Three (7.1%) of the patients abused alcohol, and two (4.8%) were smokers.

A hemostyptic agent was used in 38 (90.5%) procedures. 22 (50.0%) patients developed documented post-operative hematoma including all four patients without use of the hemostyptic agent, which was not statistically significant ($p = 0.055$).

In 13 patients (31.0%), intra-operative hemostasis was documented. Only five of these patients (38.5% of study population) showed hematoma. In 29 patients (69.0%), no hemostasis was documented intra-operatively. Only eight patients (27.6%) did not develop hematoma. Documented hemostasis showed significantly lower risk for hematoma ($p < 0.05$). In 38 patients (92.9%), a drain was inserted. 25 of these patients (64.1%) developed a hematoma. The use of a drain could not avert the development of hematoma which was not tested because of the inhomogeneity of the groups. Irrigation before wound closure showed a non-significant reduction of hematoma ($p = 0.582$).

Wound closure layer by layer was documented in 41 patients (97.6%) and showed hematoma in 15 of them. No correlation could be found regarding hematoma and surgeon's experience ($p = 0.38$). Patients with or without bed rest for 1–3 days post-operatively showed no difference in the development of hematoma ($p = 0.47$). The rate of development of hematoma or pain did not differ between the pattern of the harvested iliac crest bone ($p = 0.10$, Fig. 4), age ($p = 0.47$) or BMI ($p = 0.31$). Patients with or without pain

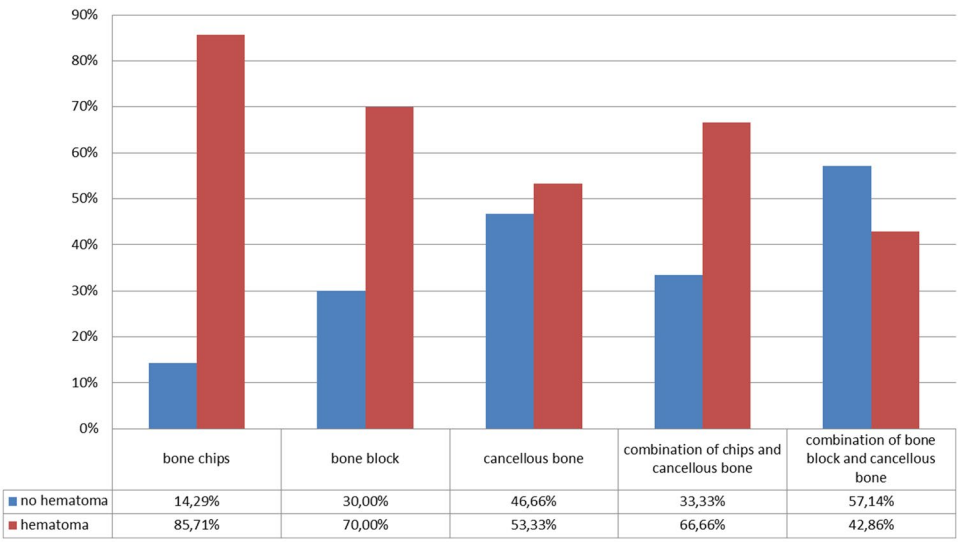

Fig. 4 Rates of hematoma dependent on the pattern of harvested bone graft

or hematoma did not differ in the length of hospital admission. There was no significant difference in surgery duration between patients with or without post-operative pain ($p = 0.08$). The use of local anesthetics did not influence post-operative pain ($p = 0.45$). One patient had a major complication with bleeding and indication for revision surgery. No sensory deficit was found at last follow-up.

Discussion

This study could show for the first time that donor site morbidity after harvesting a small quantity of iliac crest bone graft for distal radius fractures is lower than the morbidity published for harvesting larger grafts for other indications.

Stam et al. [34] showed a complication rate of 7.3% after iliac crest bone graft harvesting. In a systematic review, Dimitriou et al. demonstrated up to 18.96% complications after anterior iliac crest bone graft harvesting including 8.13% hematoma (10% of these with revision surgery), 33.83% chronic pain, 27.36% sensory disturbances, and 9.45% infections. These complications were classified as minor complications. They found 5.8% nerve injuries and 1.49% fractures classified as major complications [9]. Kitzinger et al. described a low complication rate after iliac crest bone graft harvesting using a new specialized reamer device [20]. We found hematoma during hospital admission in 61.9% of patients' records that were daily documented by nurses and/or doctors. No cases of hematoma were mentioned in the patients' reports at discharge. One patient (2.38%) received revision surgery twice for hematoma. Several authors describe hematoma from 0.85 to 9% with no discrimination between hematoma with and without indication for revision surgery [4, 9, 19, 34]. Our cohort shows similar results.

Infections after iliac crest bone graft harvesting of between 0 and 7% are described in the literature [4, 18, 34]. Barone et al. [9] reported 235 patients in a retrospective study with complications after anterior iliac crest graft harvesting, such as pain, hematoma, and one pelvic fracture but no infection. Dimitriou et al. found 1.79% infections (57 patients) in 3180 patients. Armaghani et al. described 50 patients in their study after anterior iliac crest bone graft harvesting with a 2% infection rate and conservative treatment [2]. Loeffler et al. reported 3% deep infections treated with irrigation, debridement, and systemic antibiotic therapy in their study of 92 patients [24]. All patients had co-morbidities and high-risk factors for infection. Heneghan et al. analyzed morbidity and quality of life after anterior iliac crest bone graft harvesting and found 7% of patients with wound infection [18].

Persistent pain varies in the literature between 0 and 31% [4, 16, 24, 29, 33]. Armaghani et al. and Stam et al. [2, 4] postulate that pain should have disappeared after 6 weeks. Shin reported no pain at follow-up after 4.5 years, but almost 10% of the 37 patients in their study would not give consent for iliac crest bone graft harvesting again due to pain experienced [33]. In our study, pain was documented in the first few days post-operatively in 9.5% of patients. At discharge, pain was not mentioned. At follow-up, no patient showed pain.

Revision surgery was performed in one patient (2.4%), which is in the range of already published data: Schaaf et al., Calori et al. and Fasolis et al. reported pelvic fractures with following osteosynthesis [7, 13, 30]. Heneghan described bowel perforation with a bone fragment of the iliac crest as a major complication and following laparotomy [18]. Nerve injuries with irritation of the lateral cutaneous femoral nerve are reported between 0 and 10.3% at 1 year post-operatively [4, 9, 24, 30, 33]. In our study, we did not

find any nerve injuries at last follow-up which is similar to the results reported by Barone and Shin. Although pain can be reduced using local anesthesia after wound closure, we did not see differences in patients with or without the use of local anesthesia regarding pain [38]. Similar to the results of Raposo-Amaral, we did not see differences in pain levels in patients with a different pattern of the harvested bone graft [28]. Vura et al. reported post-operative pain with a mean visual analog scale (VAS) of 7.68 for a mean period of 6.3 days. In that study, children were included, and so the results are not representative for adolescents. No nerve injuries or infections were evaluated and likewise no hematoma [37].

This study has several limitations: first, it has a retrospective design without randomization and some data were found in patients' records. Second, the study population of 42 patients is relatively small. Although no other paper regarding complications after iliac crest bone graft harvesting for distal radius fractures has been published, different results with more complications might be obtained. Third, the use of allograft bone or bone substitutes reduces donor site morbidity to zero. However, the advantage of most substitutes is not evidence based, although their use reduces pain and complications of the iliac crest to zero [17, 22, 31]. Fourth, this study shows a very low complication rate compared to published literature. This could be due to the small amount of bone graft harvested with less trauma compared to other indications for bone graft.

Compliance with ethical standards

Conflict of interest All authors have no conflicts of interest.

References

1. Ahlmann E, Patzakis M, Roidis N, Shepherd L, Holtom P (2002) Comparison of anterior and posterior iliac crest bone grafts in terms of harvest-site morbidity and functional outcomes. J Bone Jt Surg Am 84-A(5):716–720
2. Armaghani SJ, Even JL, Zern EK, Braly BA, Kang JD, Devin CJ (2016) The evaluation of donor site pain after harvest of tricortical anterior iliac crest bone graft for spinal surgery: a prospective study. Spine (Phila Pa 1976) 41(4):E191–E196
3. Arrington ED, Smith WJ, Chambers HG, Bucknell AL, Davino NA (1996) Complications of iliac crest bone graft harvesting. Clin Orthop Relat Res 329:300–309
4. Barone A, Ricci M, Mangano F, Covani U (2011) Morbidity associated with iliac crest harvesting in the treatment of maxillary and mandibular atrophies: a 10-year analysis. J Oral Maxillofac Surg 69(9):2298–2304
5. Barth A (1893) Ueber histologische Befunde nach Knochenimplantationen. Arch Klin Chir 46:409–417
6. Baschkirzew NJ, Petrow NN (1912) Beiträge zur freien Knochenüberpflanzung. Deutsche Zeitschrift für Chirurgie 113:490–531
7. Calori GM, Colombo M, Mazza EL, Mazzola S, Malagoli E, Mineo GV (2014) Incidence of donor site morbidity following harvesting from iliac crest or RIA graft. Injury 45(Suppl 6):S116–S120
8. Cummings SR, Black DM, Rubin SM (1989) Lifetime risks of hip, Colles', or vertebral fracture and coronary heart disease among white postmenopausal women. Arch Intern Med 149(11):2445–2448
9. Dimitriou R, Mataliotakis GI, Angoules AG, Kanakaris NK, Giannoudis PV (2011) Complications following autologous bone graft harvesting from the iliac crest and using the RIA: a systematic review. Injury 42(Suppl 2):S3–S15
10. Diwersi N, Babst R, Link BC (2016) Miniplates as augmentation implants in osteosynthesis of complex distal radial fractures. Oper Orthop Traumatol 28(5):402–406
11. Egol KA, Nauth A, Lee M, Pape HC, Watson JT, Borrelli J Jr (2015) Bone grafting: sourcing, timing, strategies, and alternatives. J Orthop Trauma 29(Suppl 12):S10–S14
12. Erhart S, Toth S, Kaiser P, Kastenberger T, Deml C, Arora R (2018) Comparison of volarly and dorsally displaced distal radius fracture treated by volar locking plate fixation. Arch Orthop Trauma Surg 138(6):879–885
13. Fasolis M, Boffano P, Ramieri G (2012) Morbidity associated with anterior iliac crest bone graft. Oral Surg Oral Med Oral Pathol Oral Radiol 114(5):586–591
14. Fernandez DL (2000) Should anatomic reduction be pursued in distal radial fractures? J Hand Surg Br 25(6):523–527
15. Haeseker B (1991) Van Meekeren and his account of the transplant of bone from a dog into the skull of a soldier. Plast Reconstr Surg 88(1):173–174
16. Heary RF, Schlenk RP, Sacchieri TA, Barone D, Brotea C (2002) Persistent iliac crest donor site pain: independent outcome assessment. Neurosurgery 50(3):510–516; (discussion 516–517)
17. Heiß C, Maier GS, Gelinsky M, Hose D, Schnettler R (2013) Klinische Verwendung osteologischer Biomaterialien. Osteologie 22(3):172–178
18. Heneghan HM, McCabe JP (2009) Use of autologous bone graft in anterior cervical decompression: morbidity & quality of life analysis. BMC Musculoskelet Disord 10:158
19. Kessler P, Thorwarth M, Bloch-Birkholz A, Nkenke E, Neukam FW (2005) Harvesting of bone from the iliac crest–comparison of the anterior and posterior sites. Br J Oral Maxillofac Surg 43(1):51–56
20. Kitzinger HB, Karle B, Krimmer H, Prommersberger KJ, van Schoonhoven J, Frey M (2013) Prospective study on harvesting autologous bone grafts from the anterior iliac crest using a new specialized reamer. Ann Plast Surg 71(5):566–570
21. Kuner EH, Mellios K, Berwarth H (2002) Behandlung der komplizierten distalen Radiusfraktur mit dem Fixateur externe. Unfallchirurg 105:199–207
22. Kurien T, Pearson RG, Scammell BE (2013) Bone graft substitutes currently available in orthopaedic practice: the evidence for their use. Bone Jt J, 95-B(5):583–597
23. Lameijer CM, Ten Duis HJ, Dusseldorp IV, Dijkstra PU, van der Sluis CK (2017) Prevalence of posttraumatic arthritis and the association with outcome measures following distal radius fractures in non-osteoporotic patients: a systematic review. Arch Orthop Trauma Surg 137(11):1499–1513
24. Loeffler BJ, Kellam JF, Sims SH, Bosse MJ (2012) Prospective observational study of donor-site morbidity following anterior iliac crest bone-grafting in orthopaedic trauma reconstruction patients. J Bone Jt Surg Am 94(18):1649–1654
25. Lutz M, Erhart S, Deml C, Klestil T (2016) Arthroscopically assisted osteosynthesis of intraarticular distal radius fractures. Oper Orthop Traumatol 28(4):279–290

26. Mowlem A (1945) Cancellous chip grafts for the restoration of bone defects. Proc R Soc Med, 38(4):171–174
27. Müller M, Koch P, Nazarian S, Schatzker J (1990) The comprehensive classification of fractures of long bones. Springer, Berlin
28. Raposo-Amaral CA, Denadai R, Chammas DZ et al (2015) Cleft patient-reported postoperative donor site pain following alveolar autologous iliac crest bone grafting: comparing two minimally invasive harvesting techniques. J Craniofac Surg 26(7):2099–2103
29. Sasso RC, LeHuec JC, Shaffrey C, Spine Interbody Research G (2005) Iliac crest bone graft donor site pain after anterior lumbar interbody fusion: a prospective patient satisfaction outcome assessment. J Spinal Disord Tech 18(Suppl):S77–S81
30. Schaaf H, Lendeckel S, Howaldt HP, Streckbein P (2010) Donor site morbidity after bone harvesting from the anterior iliac crest. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 109(1):52–58
31. Schieker M, Heiss C, Mutschler W (2008) Knochenersatzmaterialien Der Unfallchirurg 111(8):613ff
32. Sheehan J (1941) The use of iliac bone in facial and cranial repair. Am J Surg 52(1):55–61
33. Shin SR, Tornetta P (2016) Donor site morbidity after anterior iliac bone graft harvesting. J Orthop Trauma 30(6):340–343
34. Stam LH, Kesselring AG, Promes P, van der Wal KG, Koudstaal MJ (2014) Morbidity of harvesting the iliac crest inner cortical plate for orbital reconstruction. J Oral Maxillofac Surg 72(7):1339–1342
35. Tjardes T, Otchwemah R, Hausmann D et al (2012) Rekonstruktion segmentaler Knochendefekte Stellenwert der Spongiosaplastik. Trauma Berufskrankh 14:77–82
36. Unglaub F, Langer MF, Hohendorff B et al (2017) Distal radius fracture of the adult: diagnostics and therapy. Der Orthopade 46(1):93–110
37. Vura N, Reddy KR, G RS, Kaluvala R VR (2013) Donor site evaluation: anterior iliac crest following secondary alveolar bone grafting. J Clin Diagn Res 7(11):2627–2630
38. Zenner J, Hitzl W, Mayer M, Koller H (2015) Analysis of postoperative pain at the anterior iliac crest harvest site: a prospective study of the intraoperative local administration of ropivacaine. Asian Spine J 9(1):39–46