Drilling, not a benign procedure: Laboratory simulation of true drilling depth

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Introduction: Drilling is an integral part of almost all bony operations. Various anatomical structures coursing close to the bone are at risk if the drill bit projects beyond the far cortex. Aim of this study was to evaluate and quantify the depth to which surgeons over drill beyond the far cortex.

Materials and methods: During an AO course 153 (41 females, 112 males) surgeons and physicians were invited to participate in this study. Each participant performed 3 bicortical drillings on generic artificial bone. Polystyrene plates were mounted on the far cortex of the bone to allow for exact measurement of the over penetration of the drill bit.

Results: A total of 462 bicortical drilling manoeuvres were analysed. The average projection of the drill bit beyond the far cortex was 6.31 mm. No significant statistical correlation was noted between the specialist or the experience of the participants and depth of over drilling. Conclusions: It is remarkable that the mean and the range of far cortex over-penetration was quite similar amongst surgeons of differing grades and experience. The results of this study should return to mind to pay attention when drilling particularly in anatomical sites where nerve and vessels coursing close to the far cortex.

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6.31 mm. Each participant drilled the artificial bone three times. The mean values for over penetration of the far cortex were 6.18 mm for the first attempt, 6.47 mm for the second attempt and 6.33 mm for the third attempt. Men over-drilled by a mean of 6.14 mm (0.33–18.67 mm, ±3.18 mm) and women by a mean of 6.77 mm (2.0–17 mm, ±3.24 mm, p-value > 0.05). Trauma specialists (84 participants) over drilled by a mean of 5.97 mm (1.33–13 mm, ±2.65 mm) trauma residents (29 participants) by a mean of 6.40 mm (0.33–18.67 mm, ±4.19 mm), orthopaedic specialists (26 participants) by a mean of 6.74 mm (0.83–16 mm, ±3.45 mm), surgery specialists (11 participants) by a mean of 6.85 mm (4.67–10 mm, ±1.66 mm) and general practitioners (3 participants) by a mean of 9.22 mm (2–17 mm, ±7.5 mm). No significant statistical correlation was noted between the specialty of the participant and depth of over drilling (p-value > 0.05) (Fig. 1).

The participants were divided into three groups according to their level of experience. The novice group consisted of 30 participants with 0–1 year experience and a mean age of 30 years. They over-drilled by a mean of 6.39 mm (2.18–6.77 mm, ±3.99 mm). Group two: 1–5 years experience (98 participants, average age 33 years): 6.28 mm, 0.33–17 mm, ±3.06 mm. The expert group consisted of 25 participants and had more than five years experience with a mean age of 38 years. They over-drilled by a mean of 6.33 mm (3.33–13 mm, ±2.75 mm). There was no significant statistical correlation between experience and over drilling (p-value > 0.05).

Discussion

The consequences and complications of drilling beyond the far cortex and injuring the soft tissues is well described in the literature. There is little data, however, on the depth to which surgeons tend to over drill. Al-Rashid et al. reported the rupture of the extensor pollicis longus tendon following volar plate osteosynthesis of the distal radius. The exploration of the extensor compartment did not show evidence of screw protrusion, but demonstrated an empty drill hole on the floor of the third compartment. Grimaldi et al. report the case of an 85-year-old patient presenting with an intertrochanteric fracture, treated by a cephalo-medullary nail and complicated by a superficial femoral artery laceration at the level of the distal locking screw, caused by drilling. Numberous other cases of injury to the femoral vessels during osteosynthesis of proximal femoral fractures have been reported in the literature. Unfortunately other major vessels are also at risk from orthopaedic implants or instrumentation. These include the axillary artery following procedures about the shoulder, the subclavian artery in osteosynthesis of the clavicle and the popliteal vessels during osteosynthesis of proximal tibial fractures and arthroplasty.

Probably the most catastrophic surgical iatrogenic vessel complications occur about the spine. Vertebral artery injury in cervical spine surgery is associated with fistula formation, pseudoaneurysm, cerebral ischemia, and death. In anterior cervical procedures the artery is at great risk when drilling off the midline. The course of vertebral artery is not visible in posterior cervical spine surgery, thus the vessel is in great danger if the far cortex is over penetrated during drilling, tapping and screw insertion. In the thoracic, lumbar and sacral spine it is not the drill but the over penetration of screws that can abut the descending aorta and the iliac vessels with occasionally fatal consequences. This experimental study reveals that even experienced surgeons penetrate the far cortex by a mean of 6.33 mm (3.33–13 mm). All participants were informed about the purpose of this study, thus it is possible that greater caution would have been exercised by the participants. With this in mind, the results of this study are indeed remarkable.

Conclusions

The results of this study clearly demonstrate that drilling is not a benign procedure. This course is not new information but what is interesting the mean and the range of far cortex over-penetration by surgeons of all grades and experience. This should be borne in mind by the surgeons particularly in anatomical sites where nerve and vessels are in very close proximity to the far cortex.

References

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