ABDOMINAL INJURIES DUE TO THE USE OF GUIDE WIRE IN HIP SURGERY EXPERIMENTS. CADAVERIC STUDY

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ABSTRACT

Objectives: Evaluate the relationship between abdominal injuries and the introduction of guide wire in experimental hip surgery, to propose a scoring system and a medical management based on the distance traveled by the guide wire from the quadrilateral plate until the damaged anatomical structure. Material and Methods: 18 cadaveric hips, a Steimann pin of 3.2 x 300mm, an electric drill and a caliper were used. The wire was inserted in the center of the femoral neck through a lateral approach in the hip under direct visualization. Via median abdominal extended approach to the pelvic region, the quadrilateral plate was observed until the wire crossed it. From this point the wire was further inserted 140 mm in order to observe its abdominal path and describe the lesions presented based on the distance traveled. Results: There were five lesions (27%) in the sigmoid colon, and one transfixing injury (5%) of the obturator nerve. The common iliac arteries and veins from the contralateral hip were not injured. Conclusion: The guide wire must not exceed the quadrilateral plate. Preventive measures are important in the pre- and intra-operatory stages and the score and medical management proposed in this study should be carefully observed in cases of injury.

Keywords: Anatomy. Wounds and Injuries. Hip fractures. Orthopedic wire.

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INTRODUCTION

The incidence of fractures of the proximal third of the femur, particularly intertrochanteric and femoral neck fractures, has gradually increased in recent decades, particularly in developed countries, where there is a considerable number of elderly people who are more susceptible to this kind of fracture.[1]

The estimated number of fractures of the proximal third of the femur worldwide was approximately 1,260,000 and the forecasts for 2050 are for 4,500,000 cases/year, representing an important socioeconomic problem.[1]

Studies currently prove that the fixation of interthrocanteric fractures or femoral neck occur prioritarily with the use of implants that obligatorily use guide wires in their surgical technique, as are the cases of the Dynamic Hip System (DHS),[2] and of the cannulated screw (CS).[3]

In the surgical act, the positioning of the synthesis in hip surgery, when using the DHS, should always be centralized both in the anteroposterior direction, and in the laterolateral direction of the femoral neck, respecting the pin-apex distance (PAD).[4] This distance determines the ideal positioning of the sliding pin at the articular surface of the femoral head and is obtained by the correct positioning of the guide wire. This positioning is also recommended in the use of the CS, in which the position can be more variable, depending on the fracture to be treated. However, the principle of greater stability of the synthesis should always be a priority.[5]

In both cases the ideal positioning of the guide wire is always very close to the articular surface of the femoral head.[2-4] Therefore, during the use of the triple reamer, in the DHS, or with the use of the cannulated drill, in the CS, the guide wire might migrate to the central region of the acetabulum, as there is thermal necrosis of the bone. Accordingly, there is a mechanical obstruction of the cannulated fistula orifice of the instruments, locking the guide wire to these, and often surpassing the quadrilateral plate and penetrating the pelvis, particularly in osteopenic or osteoporotic patients. This can be confirmed by intra- or postoperative radiographic control, through visualization of the guide wire in the abdominal cavity. (Figure 1) In some cases the incorrect use of the surgical technique may also occur, as can be observed in Figure 2.

All the authors declare that there is no potential conflict of interest referring to this article.

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Figure 1 – *Intraoperative radiography of use of the triple reamer of the DHS (135º), demonstrating the inadvertent introduction of the guide wire beyond the quadrilateral plate of the acetabulum.*

Figure 2 – *Intraoperative radiography of fixation of proximal femur fracture with use of the DHS (135º), demonstrating the accidental introduction of part of the guide wire beyond the quadrilateral plate, after incorrect application of the synthesis implantation technique.*

In view of the foregoing, this study is aimed at evaluating the relation between intra-abdominal lesions and the introduction of guide wires in surgical assays of the hip, as well as proposing a scoring system and medical conduct according to the distance covered by the guide wire from the quadrilateral plate and the injured anatomical structure.

MATERIAL AND METHODS

Eighteen hips of adult cadavers without fracture of the hip or pelvis and without previous history of abdominal surgery were used in the study. The vesicle content was emptied by direct punction. Two access routes were employed, one lateral to the hip (Hardinge), until the point of visualization of the entire proximal femur (Figure 3 A, B) and the other longitudinal median extended to the pelvic region. Abdominal and retroperitoneal dissection was performed in the pelvic cavity through the latter route, until complete visualization of the quadrilateral plate. This was followed by the Whitman maneuver (traction, abduction and internal rotation) to simulate the positioning in the intraoperative stage. As the studied hip did not have a fracture, abduction and internal rotation were followed by

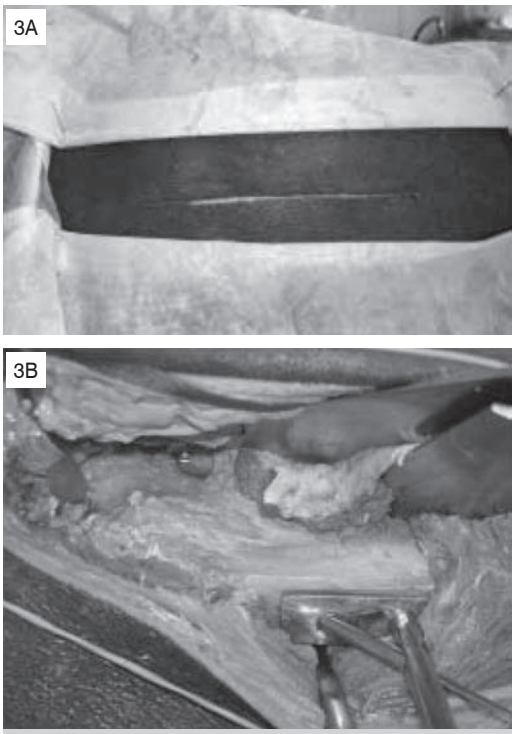

Figure 3 A, B – *Lateral access pathway in the hip, with direct visualization of the femoral neck and positioning of the wire with angular guide.*

the introduction of the 3.2 x 300 mm Steinmann wire through the lateral side of the femur with the aid of an electric drill. The guide wire angulation of 135º and the center of the femoral neck were respected, as can be seen in Figure 3B, until the wire perforated the quadrilateral plate. This observation was made by means of the median abdominal incision (Figures 4 and 5). From this point on the guide wire was introduced for another 140 mm, in the same direction. The small intestine was separated due to its considerable mobility in vivo, which may interfere in the results of the intraoperative phase. This procedure allowed the observation of the whole passage of the guide wire and the description of the lesions caused. The measurements were taken from the quadrilateral plate with the aid of a Vonder caliper rule, and the results expressed in millimeters, as can be seen in Table 1.

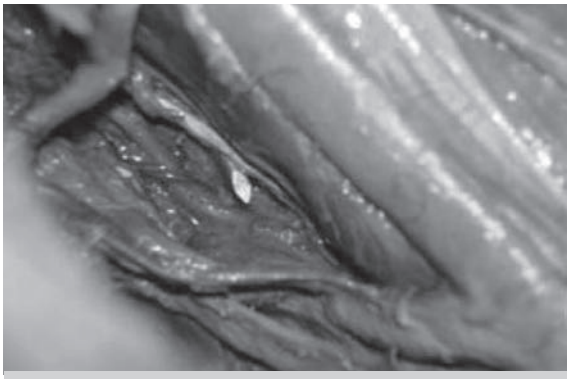

Figure 4 – *Intra-abdominal observation of penetration of the wire in the quadrilateral plate and its proximity to left obturator nerve.*

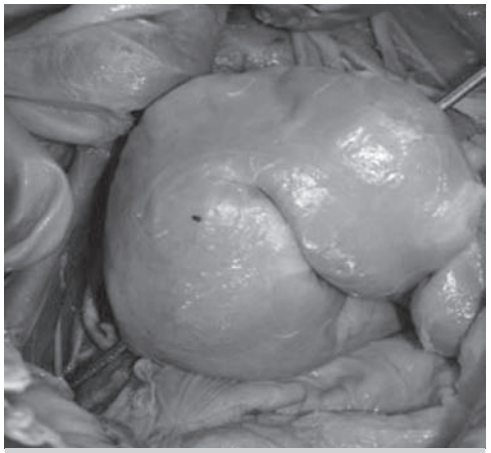

Figure 5 – *Intra-abdominal observation of the entire passage of the guide wire in the right hip and transfixing of the sigmoid colon.*

Table 1 – *Data relating to the mean distances covered by the guide wire in mm according to the anatomical structure.*

Anatomical structures	Side	Mean Distance (mm)	SD	Median	Minimum	Maximum
Obturator nerve	right	1.78	0.97	2	1	4
	left	1.56	1.01	1	0	3
Sigmoid Colon	right	40.2	12.3	40	25	60
	left	40.7	12.1	48	20	55
Common Iliac Artery and Vein	right	117.7	12.1	120	100	140
Contralateral to the fixed hip	left	117.0	10.7	121	100	129

SD: Standard Deviation

RESULTS

Five (27%) sigmoid colon lesions occurred, four of which arose from the introduction of the wire in the right hip (Figure 4), at an average distance of 40.2mm from the quadrilateral plate. It is worth emphasizing that the majority of injured colons were distended. There was one (5%) transfixing lesion of the obturator nerve (Figure 6), while the other seventeen were deviated by the guide wire at an average distance of 1.78mm to the right and 1.56mm to the left. Lesions of the common iliac arteries and veins contralateral to the fixed hip were not observed, yet in eight (44%) hips the guide wire deviated from these structures at an average distance of 117.7mm to the right and 117.0mm to the left (Figure 7). These values can be visualized in Table 1.

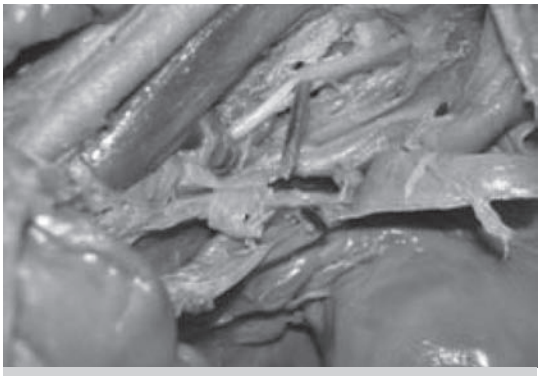

Figure 6 – *Observation of lesion of the obturator nerve of the left hip.*

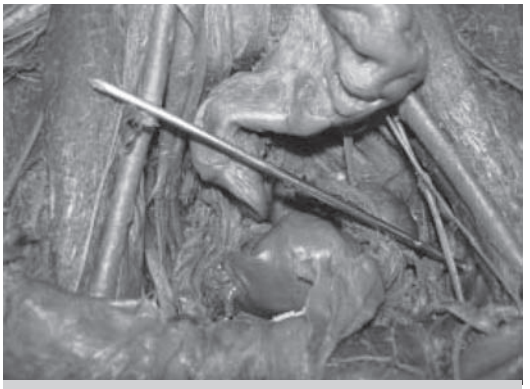

Figure 7 – *Observation of the guide wire deviating the common iliac artery and vein contralateral to the left hip.*

The external iliac arteries and veins ipsilateral to the studied hip were not injured or submitted to risk as the wire was centralized to the neck and the hip was abducted and rotated internally. When penetrating the pelvis the wire is always located at a relatively safe distance to the posterior of these vascular structures, as can be observed in Figure 4. However, this maneuver positions the wire in the direction of the ipsilateral obturator nerve and contralateral iliac artery and vein.
No vesicle lesion was observed as this viscus was completely emptied, prior to the introduction of the guide wire.
The small intestine was not injured either because it was removed from the pelvic cavity prior to the introduction of the guide wire.

DISCUSSION

Intrapelvic lesions due to penetration of guide wires or sliding screws in hip surgeries are described in literature.[6,7] Although rare, when they occur they can injure vascular structures as described by Clifford et al.[8], and can even be fatal as reported by Siegel. et al.[9] Determining clinical follow-up after this intercurrence is of great importance, as even if the wire is removed through the synthesis introduction access route as described by Mishra et al.[10] complications can arise even though at a late stage.[11] Thus an early diagnosis is determinant in the lesion prognosis.
Feeney et al.[6] conducted surgical assays on cadaver hips and demonstrated the occurrence of intracavitary lesions in the introduction of three guide wires in a triangular formation as proposed for femoral neck fracture fixation. In ten cadavers studied with introduction of 60 guide wires, they noticed 12 cases of rectum lesions, 8 of internal iliac vessel lesion, 5 sigmoid colon lesions, 4 bladder lesions, 2 small intestine lesions and 1 urethra lesion. No correlation between the intracavitary distance covered by the wire and the lesion was presented in this experiment.
In a case report, Siegel et al.[9] described a fatal injury of the external iliac vein ipsilateral to the fixed hip. During the use of the triple reamer there was penetration of the guide wire in the pelvic cavity with injury of the external iliac vein. In this case it is possible to observe that the hip was rotated externally and the guide wire was positioned anteroinferiorly in the femoral neck. In view of such an observation it is suggested that the positioning that simulates the Whitman reduc-

Chart 1 – *Score according to the penetration of the guide wire in the pelvic cavity, of the structures under risk and of the clinical evaluation.*

Score	Intrapelvic penetration of the guide wire (mm)	Structures at risk	Clinical evaluation
A	⩽ 4	- Obturator nerve	• Motor function of the hip adductors and sensitivity of the medial side of the thigh.
B	5 to 20	- Obturator nerve - Sigmoid colon (low risk)	• Clinical evaluation for peritoneal irritability • X-rays in abdominal orthostatism (Pneumoperitoneum)
C	21 to 100	- Obturator nerve - Sigmoid colon (moderate risk)	• Clinical evaluation for peritoneal irritability. • Digital rectal examination (blood test) • Abdominal X-rays in orthostatism (Pneumoperitoneum)
D	>100	- Obturator nerve - Sigmoid colon (high risk) - Contralateral common iliac artery and vein	• Clinical evaluation for peritoneal irritability. • Digital rectal examination (blood test) • Abdominal X-rays in orthostatism (Pneumoperitoneum) • Palpation of femoral pulse contralateral to the operated hip

tion maneuver and centralization of the guide wire in relation to the femoral neck – during use of the DHS - should always be adopted, even if the fracture is reduced, as it diminishes the possibility of vascular injury due to small penetrations of the guide wire.

In the use of the CS the guide wire that is positioned anteroinferiorly to the femoral neck should be permanently monitored with the AID of the image intensifier. In this position if the wire penetrates the pelvic cavity, even with the Whitman maneuver, there might be an injury of the external iliac artery or vein ipsilateral to the fixed hip even with small penetrations.

It is recommended to perform delay or relief vesicle probing in the immediate preoperative period, since this procedure diminishes the risk of lesions in this viscus.

Mishra et al.[10] described two cases of penetration of guide wires in the pelvic cavity in hip surgery and proposed some recommendations to avoid this kind of complication: 1) Observe the cleanliness of the cannulated orifice of the drill and of the plugs; 2) Avoid reuse of the guide wires; 3) Use cannulated instruments from the beginning to the end of surgery; 4) Perform radiological monitoring throughout the surgical procedure.

Any penetrations that may occur beyond the quadrilateral plate should be measured, either by what remained of guide wire in the femoral lateral cortical, or by means of radiological control. Radiographic magnification at around 15 % should be taken into account, and the following behavior should be adopted, according to the scores proposed by the authors in Chart 1.

The following medical management is suggested based on the analysis of data and information contained in Chart 1: score A – Presence of obturator nerve function deficit – perform clinical follow-up in the postoperative period, in dealing with a permanent neurological lesion perform hip rebalancing if so required; score B – Keep patient in hospital for a period of no less than 48 hrs for screening for acute abdomen and in the presence of clinical signs for colonic lesion indicate laparotomy; score C – Remove the wire through the lateral access pathway and together with the general surgeon keep the patient in hospital for a period of no less than 72 hrs for screening for acute abdomen and in the presence of clinical signs for colonic lesion indicate laparotomy; score D - If possible to remove the guide wire through the lateral access pathway, follow medical management of score C, if not possible to remove the wire through the lateral access pathway, indicate exploratory laparotomy for removal of the guide wire and review of cavity, including observation of iliac vessels contralateral to the operated hip.

CONCLUSIONS

In keeping with the results obtained it is concluded that:

- The guide wire should not surpass the quadrilateral plate in hip surgeries under risk of injuring neurovascular structures and the large intestine;
- Preventative measures such as the use of the Whitman maneuver and use of the image intensifier are of vital importance to reduce both the occurrence of penetration of the guide wire in the pelvic cavity and the severity of lesions associated with such a complication;
- In cases of inadvertent pelvic penetrations with centralized guide wire and positioning of the operated limb in traction, abduction and internal rotation, the score and the medical management proposed by the authors should be carefully adopted.

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