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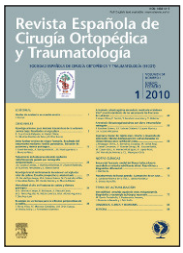

CLINICAL NOTE

Experience in the Use of Ultrasonic Scalpels in Orthopaedic Surgery

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KEYWORDS
Ultrasonic scalpel;
Surgery;
Haemostasis;
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Abstract
Objective: To compare the effects using the monopolar electric and ultrasonic scalpel on muscle tissue in oncological surgery.
Material and method: Muscle tissue samples were collected from 6 patients. Two samples were obtained from each one of them: one using an electric scalpel and another with an ultrasonic scalpel, which then analysed in histopathology.
Results: Less necrosis and better tissue viability was observed in the areas cut with the ultrasonic scalpel compared to the areas where the electric scalpel was used.
Conclusions: The ultrasonic scalpel has a cutting capacity and haemostasis comparable to the electric scalpel, causing less damage to the tissue on which it is applied.

PALABRAS CLAVE
Bisturí ultrasonidos;
Cirugía;
Hemostasia;
Sangrado

Experiencia en la utilización de bisturí de ultrasonidos en cirugía ortopédica

Resumen
Objetivo: Comparar el efecto de la aplicación del bisturí eléctrico monopolar y el de ultrasonidos sobre el tejido muscular en cirugía oncológica.
Material y método: Se recogieron muestras de tejido muscular de 6 pacientes. En cada uno de ellos se obtuvieron 2 muestras: una mediante corte con bisturí eléctrico y otra con bisturí de ultrasonidos que se analizaron en anatomía patológica.
Resultados: Observamos una menor profundidad de necrosis y mejor viabilidad tisular en las zonas de corte con bisturí de ultrasonidos, respecto a las zonas en las que se empleó el bisturí eléctrico.
Conclusión: El bisturí de ultrasonidos proporciona una capacidad de corte y hemostasia comparable a la del bisturí eléctrico, ocasionando un menor daño a los tejidos sobre los que se aplica.

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Introduction

The ultrasonic or harmonic scalpel is being used more and more frequently and in more modalities of surgery with particular success in the type of intervention for which it was designed, namely laparoscopic surgery.

When an ultrasonic scalpel is used for dissection or haemostasis, high frequency ultrasound waves are applied to the tissues treated. This instrument cuts and coagulates thanks to the mechanical vibration it generates. In contrast, electrocautery or conventional electric scalpel applies a thermal effect to the tissues that, oftentimes, produces burns due to the fact that its functioning implies the passage of active current through the patient.

The use of the ultrasonic scalpel in orthopaedic surgery is not usual, although it offers advantages in certain interventions such as in oncological surgery of the locomotive system, when it is necessary to perform broad resections by means of atypical approaches and when it is particularly important to preserve the tissues that are not to be resected for the reconstructive phase and subsequent healing. Likewise, it makes the pathology study easier in tumour resection and, in particular, the analysis of resection margins.

We aim to show the differences we have found in the approach to muscle tissue with each scalpel, as well as review the indications for the use of the ultrasonic scalpel in surgery orthopaedic.

Material and method

The ultrasonic scalpel has been systematically used for large, soft tissue sarcoma resections since 2008. We collected tissue samples from 6 patients suffering from soft tissue sarcomas located in the extremities in whom broad resection of the tumour had been planned between April, 2008, and June, 2009. An *Ultracision*® (Ethicon Inc., USA) ultrasonic scalpel was used for surgery, in combination with a frequency generator of 55.5 kHz, HSA07 hand-pieces, and the HC145 curved tipped blade. Once the surgery had been completed, a sample of healthy muscle tissue was resected using the ultrasonic scalpel and another one with the conventional scalpel. In all the cases resected with the ultrasonic scalpel, the incision was made applying a level 5 frequency generator (as indicated for sectioning). In the samples obtained by means of the conventional scalpel, a monopolar *KLS Martin*® *ME-MB2* device (KLS Martin Group, Germany) was used. The terminals of this system were set to 70 for coagulation and 90 for cutting, according to the power meter scale on the console. With this intensity we performed appropriate soft tissue section and haemostasis of bleeders.

Both surgical specimens were identified in different sample containers, marking the section edge of the tissue with a surgical marker. The samples were sent to the Pathology Department of the Hospital and were received, processed, and analyzed by the team of pathologists belonging to the centre's Sarcoma Unit.

Results

The gross examination revealed no differences between both groups of samples. During resection with adequate zx [falta algo aquí], tissue vaporization was seen with no smoke, characteristic of the conventional scalpel. On histological analysis, the effect of both instruments on all the samples was evident on the resected tissue with coagulative necrosis. However, differences were found with respect to the thickness of said necrosis, margin regularity, as well as changes in the deeper tissue outside the area of necrosis (table 1).

In the sections made with the conventional scalpel, the necrotized tissue was 0.65±0.1 mm (range: 0.5-0.9 mm) thick, whereas in the tissues sectioned with the ultrasonic scalpel, the values were 0.36±0.06 mm (range: 0.2-0.6 mm). On the other hand, the margins of the coagulative necrosis versus the beginning of the healthy, viable tissue were more regular and uniform in the samples obtained with the ultrasonic scalpel than with the conventional scalpel. We also observed that immediately next to the necrotic tissue in the samples obtained with the ultrasonic scalpel, there was viable tissue, whereas adjacent to the coagulative necrosis in the cases treated with the conventional blade, the tissue was interpreted as viable, although the tissue structure was not normal. In one patient (number 5), we noted that the thickness of the coagulative necrosis that formed with the electric scalpel was less thick than that created by the harmonic scalpel. However, although the tissues immediately adjacent to the necrotized area of the sample obtained with the ultrasonic scalpel were normal, the tissues located immediately adjacent to the necrosis caused by the conventional scalpel presented changes.

Both dissection and haemostasis are achieved more slowly with the ultrasonic scalpel than with conventional instruments. However, given that haemostasis is achieved simultaneously with the cutting, there is less bleeding in the dissected planes with the ultrasonic scalpel and surgical time is not protracted with respect to surgery with conventional instruments.

Table 1 Necrosis intensity and thickness (mm) in the muscle samples

Patient	Electric scalpel		Harmonic scalpel	
	Necrosis	Thickness (mm)	Necrosis	Thickness (mm)
1	++	>0.6	—	<0.3
2	++	>0.6	+	<0.3
3	+++	>0.9	+	<0.4
4	+++	>0.6	—	<0.2
5	++	>0.5	+	<0.6
6	+++	>0.9	+	<0.4

Discussion

Due to the fact that it's hard to calculate the penetration of the heat in the tissue when a conventional scalpel is applied, burns can be produced at the point of application, in adjacent structures, or even at a distance if the heat is conducted by the tissues. These burns can give rise to major complications[1] and it has been established that the extension of thermal injury caused by each of the two scalpels can differ by up to 50%,[2] which is consistent with our observations. The ultrasonic scalpel makes use of a different mechanism to achieve its aim, as it applies ultrasound to the tissue and produces 3 effects that are not accomplished with the conventional blade, such as cavitation, haemostasis, and cutting. These 3 effects can be applied individually or in combination. Synergy depends on the type of tissue (water content); on the type of applicator and its set-up parameters (extension of longitudinal oscillation); on the duration of the energy applied, and the application of traction or pressure to the tissue on which it is being used.[2,3]

Cavitation is described as the formation and disintegration of vaporized bubbles in a liquid medium. This mechanism causes the parenchymal tissue cells to explode and bubbles to form in the connective tissue and facilitates dissection of the tissues involved. If pressure is simultaneously applied to the tissue, the tertiary hydrogen bonds of proteins are broken. This fragmentation of the protein bonds at low temperature fosters compression of collagen molecules: the coaptation effect. Sustained application of this energy locally produces a rise in temperature that leads to thermal induction of steam and water release and, as a result, protein denaturalization provoking haemostasis. If pressure or traction is applied to the tissue at the same time, the high frequency vibrations of the tip of the instrument stretch the tissue to its elastic limit, allowing for a clean section.

The ultrasonic scalpel can be used as a conventional scalpel, while at the same time taking advantage of its haemostatic effect.[2,3] This is in line with our own clinical experience. In all the cases, it was possible to use the harmonic scalpel to dissect the tissues with minimal bleeding accomplishing haemostasis by applying pressure with the instrument itself.

The risk of thermal injury when using the ultrasonic scalpel is very low. The depth of penetration of the energy current is linearly correlated with the time of application and, in this way, can be controlled during use. Moreover, the lateral propagation of the active energy flow follows the same pattern; hence, it can be controlled in the same way.[2,3] None of our patients suffered thermal burns.

In animal experiments, Spivak et al[4] demonstrated that in small (0.24-0.5 mm) and medium-sized arteries (2-3.5 mm) haemostasis can be achieved equally safely with the ultrasonic scalpel, conventional scalpel or clips. The advantage of the ultrasonic scalpel is that dissection and haemostasis can be accomplished without having to change instruments. We have not checked intra- and post-operative bleeding to compare the efficacy of one method versus the other, although we did observe that, although tissue dissection was faster and surgical planes had little bleeding on the margins, a longer application time is required with the ultrasonic scalpel than with the conventional one when seeking to achieve haemostasis on a bleeding vessel. It has been seen that in standard interventions, surgical time can be lessened using the ultrasonic scalpel in comparison with the conventional one.[5]

The literature has failed to clarify the extent of the tissue damage produced by the use of the ultrasonic scalpel. In experimental studies with animals, the tissue damage caused by the harmonic scalpel was interpreted as being greater than that provoked by a conventional blade, although the formation of adhesions to neighbouring tissues was not seen to be any greater.[6] In a series of experiments carried out with pigs, the formation of post-operative adhesions and trauma to the tissues was significantly less with the ultrasonic scalpel versus the conventional scalpel or laser.[7]

Laparoscopic technique demands much greater prevention of haemorrhage than in open surgery, given that, if it presents, conversion to open surgery may be inevitable. In any case, and in order to avoid prolonging surgical time, as well as to lower costs, the instruments used should be valid for both modalities in a single surgery. The ultrasonic scalpel possesses these properties and is therefore being used more and more often in thoracic[8] and abdominal[9] surgery or in open interventions on vascularized parenchyma of organs such as the kidneys or the liver.[10]

In our experience, the ultrasonic scalpel enables dissection through well defined planes to be carried out more quickly than with a conventional one; it enables excision with minimal damage to structure for accurate evaluation by the pathologist, as well as for reconstruction and healing in patients themselves; furthermore, bleeding during surgery is less than with the conventional scalpel.[11,12] Additionally, it prevents the inconvenience of smoke formation while the conventional scalpel is being used, although it must be said that the vaporization generated by the ultrasonic scalpel can splatter, making protection for the face and eyes recommendable.

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