

Study of the damage rate caused by intervertebral foramen type inside and outside and the pass of the intervertebral DRG RF puncture way

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Abstract: This paper was to analyze and contrast the damage rate on the thoracic segment different position of the dorsal root ganglion (dorsal root ganglion, DRG) caused by different puncture path in radiofrequency ablation, thus the best RF target way for the thoracic segment of different types of DRG was confirmed. According to the difference of puncture and ablation damage way, 14 segmental spinal specimens were randomly divided into three groups, and then conducted DRG radiofrequency damage on percutaneous puncture path according to the type of DRG position. The damage effect of different puncture path by the judgment standard of the result of pathology analyzed. The experiment showed that RF damage of group A were 72.58±18.88%, 54.16±24.84% and 32.85±28.11%; that of group B were 77.86±15.15% and 72.02±17.86%, 57.14±18.02% and 52.47±20.64%, 68.75±14.63% and 71.78±16.00%; and that of group C were 82.46±14.10%, 81.53±11.81% and 80.83±13.33%. It was concluded that the singleness of DRG puncture route is one of the important reasons for the poor thoracic segments DRG radio frequency (RF) ablation effect. While according to the type of DRG different positions with double joint puncture path can significantly improve the rate of DRG RF damage.

Keywords: Dorsal root ganglion, puncture path, radio frequency (RF), interventional therapy.

INTRODUCTOIN

Dorsal root ganglion (DRG), also called the backbone ganglion, is formed by the gathering of primary sensory neurons cell body, and connected to the spinal cord and a sensor by borrow peripheral. It is the connection bond between internal and external environment of the body and the spinal cord. Neuropathy pain (Neuropathic pain, NP) is the pain caused by peripheral or central nervous system lesions or dysfunction. Study (Sapunar *et al.*, 2012) showed that the acute or chronic DRG excitatory changes caused by nerve damage and the reshaping between the spinal dorsal horn neurons and synapses plays an key role in the NP formation mechanism, and the pain reduced or disappeared significantly on the interruption of DRG sensory signals, so currently NP treatment focuses on the DRG treatment (Shanthanna *et al.*, 2012). As one of more common clinical chronic pain, and with the characteristics of spontaneous pain, hyperalgesia and pain hypersensitivity, NP has badly affected the quality of patient's life. Clinical commonly used drug treatment, but for certain rational intractable neuropathy pain, drug treatments is in poor effect and there will be large side effects of long-term use of drugs. Clinical radio frequency (radio frequency, RF) technology has been applied to the treatment of various chronic pain for more than 30 years, and RF is one of the interventional therapy for treating chronic pain, which generates therapeutic heat by going through the central and peripheral nervous system, so as to damage nerve

fibers and block transmission of nerve impulses to treat pain (Yung *et al.*, 2012).

Trigeminal neuralgia (trigeminal neuralgia, TN) and traces of after herpes zoster neuralgia (post herpetic neuralgia, PHN) are clinical common and typical NP, but both the clinical efficacy of RF treatment are significantly different. In addition to the poor effect of PHN (about 55% occur in the chest) intervention caused by DRG complex anatomy through relationship and mutation (Yong *et al.*, 2011), the puncture positioning accuracy, the deficiency of the DRG targeted way study are also the leading cause of the poor efficiency. DRG position can be divided into intervertebral foramen type appearance, intervertebral groove and spinal canal according to the relationship with the intervertebral foramen. The choice of targeted way is necessarily different with the different DRG position. At present, the widely adopted puncture pathways in thoracic segment of herpes zoster radiofrequency treatment are CT, DSA or C arm through a single intervertebral foramen puncture guided by the corresponding segments intervertebral foramen (Yan *et al.*, 2012). According to radio frequency (RF) ablation, the principle of direction along the long axis of the DRG puncture should be used, theoretically intervertebral foramen exterior DRG puncture appropriate intervertebral foramen puncture pathway and/or the small joints of the lateral limbus approach, intervertebral pass DRG should select the intervertebral foramen puncture pathway and/or through the lamina incisure, spinal canal type DRG can choose the small flange joints inside way and/or the lamina incisure way (Guoping *et al.*, 2012).

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MATERIALS AND METHODS

Materials

Fourteen corpses of normal adults in good color and texture, fixed by formaldehyde were provided by a College of Human Anatomy Teaching and Research Section in Basic Medical College.

Selection criteria: 1) spinal scoliosis deformity; 2) no history of spinal surgery 3) indicate the death bodies record sheet not because the spine, spinal cord, thoracic nerve disease. Found in 4) the anatomy of the spinal ganglion and no lesions or normal DRG.

Depending on the puncture and ablation damage way (shown in fig. 1), 14 segmental spinal specimens is divided into three groups (A group of two, whatever the DRG position type, adopt single through intervertebral foramen puncture; group B of six, according to the different kinds of DRG location adopt corresponding different single puncture; group C of six, according to the different position of DRG adopt dual targeted way accordingly).

Specimen grouping: according to different damaged puncture and radio frequency way, 14 segmental spinal specimens were randomly divided into three groups (group A is used only by the intervertebral foramen way puncture group, 2, A total of 48 DRG; group B according to the DRG classification and the corresponding single puncture pathway group, 6, A total of 144 DRG; according to the type of DRG and group C with double way puncture approach group, 6, A total of 144 DRG).

The main equipment

GE Light-Speed VCT64 row CT, GE Discovery MR 750 3.0T, with image post-processing workstation (GE advantage workstation 4.2); The United States Smith ET-20s multi-functional radio frequency wave of heat treatment system.

Scanning methods: CT scan parameters: the specimens in the supine and cephalic advanced placement position; Tube voltage is 120kv, tube current is 180~400 mAs, pitch is 0.984mm, layer thickness is 5mm, layer of reconstruction thickness is 0.625mm, the matrix is 512 by 512. Use the CT machine with build-in GE advantage workstation 4.2 workstation to have a three-dimension reconstruction to image.

Specimen collection:

After the completion of the radio frequency (RF) damage, under the guidance of a professor of anatomy, firstly take out the DRG specimens by anatomical saw, rongeur and scalpel and then put it in 10% formalin solution to preserve it and mark specimen number, and finally embed it by paraffin and section before HE staining.

DRG Damaged Pathological Judgment Standard

Two senior title of professional pathologists observed DRG slice under optical microscope, and use the microscope camera system exported pathological to JPG format images, use Photoshop CS6, Adobe Inc.) image processing software to trace out DRG neurons in coagulation necrosis area, and to calculate the necrosis area and the damaged degree of DRG to determine the ratio of DRG (fig. 2).

Statistical Processing

Using Mean (Mean) \pm standard to show Quantitative data (S), using single factor variance (One-Way ANOVA) to compared between groups, $P < 0.05$ for the difference was statistically significant, using spss17.0 statistical software (SPSS Inc) for data processing and analysis.

RESULTS

A, B, C three groups of DRG profile data are shown in table 1.

Results of Group A

A total of 48 in group A through intervertebral foramen puncture DRG, RF damage rate is $62.18 \pm 25.85\%$; Each subtype of damaged rate are shown in table 2.

Results of Group B

In group B, a total of 43 for intervertebral foramen exterior subgroups through the small joints of lateral edge way to puncture DRG, RF damage rate is $71.86 \pm 15.15\%$; a total of 45 for intervertebral foramen through intervertebral foramen of exterior subgroups to puncture DRG, RF damage rate is $72.02 \pm 17.86\%$; a total of 14, subset through intervertebral foramen intervertebral groove puncture DRG, RF damage rate is $57.14 \pm 18.02\%$; a total of 16, intervertebral subgroups according to pass through the lamina incisure to puncture DRG, RF damage rate is $52.47 \pm 20.64\%$; a total of 12, the small joints of intra-spinal canal type subgroups lateral margin way to puncture DRG, RF damage rate is $68.75 \pm 14.63\%$; a total of 14, Spinal canal type subgroups by lamina incisure way to puncture DRG, RF damage rate is $71.78 \pm 16.00\%$ (table 3).

Results of Group C

In group C, intervertebral foramen exterior subgroups using through small articular process the lateral edge joint through intervertebral foramen puncture DRG 69, radio frequency (RF) damage rate of $82.46 \pm 14.10\%$; Intervertebral groove subgroups with intervertebral foramen way combined the lamina incisure way puncture DRG, a total of 39, RF damage rate of $81.53 \pm 11.81\%$; Type spinal canal subgroup made through small articular process inside edge joint through the lamina incisure puncture DRG, a total of 36, RF damage rate of $80.83 \pm 13.33\%$ (table 4).

Table 1: A, B, C three groups of DRG profile data

Group	DRG position type	Puncture path	Break time	Temperature	Number	Total number
Group A	Intervertebral foramen subgroups	The intervertebral foramen puncture path	90 s	80°C	1	29
	The pass of the intervertebral subgroups	The intervertebral foramen puncture path	90 s	80°C	1	12
	Spinal canal type subgroups	The intervertebral foramen puncture path	90 s	80°C	1	7
	Intervertebral foramen subgroups	Approved by intervertebral foramen approach or the small lateral articular process Edge way	90 s	80°C	1	88
Group B	The pass of the intervertebral subgroups	The intervertebral foramen way or lamina incisure way	90 s	80°C	1	30
	Spinal canal type subgroups	Approved by lamina incisure approach or the small joints Lateral margin approach	90 s	80°C	1	26
	Intervertebral foramen subgroups	Approved by intervertebral foramen way to joint the small joints Lateral margin approach	90 s	80°C	2	69
Group C	The pass of the intervertebral subgroups	The intervertebral foramen way joint lamina incisure way	90 s	80°C	2	39
	Spinal canal type subgroups	Approved by lamina incisure approach combined the small joints The inside edge way	90 s	80°C	2	36

Table 2 Subtypes Damage Rate of Group A

DGR position type	RF targeted way	Number of damaged DGR	Damage degree%
Intervertebral foramen subgroups	The intervertebral foramen	N=29	72.58±18.88
The pass of the intervertebral subgroups	The intervertebral foramen	N=12	54.16±24.84
Spinal canal type subgroups	The intervertebral foramen	N=7	32.85±28.11
Does not distinguish between DRG location type	The intervertebral foramen	N=48	60.62±25.65

Table 3 the Subtype Damage Rate of Group B

DRG position type	RF puncture path	Damaged DRG number	Damage degree %
Intervertebral foramen subgroups	Through small joints lateral margin	N=43	71.86±15.15
	The intervertebral foramen	N=45	72.02±17.86
The pass of the intervertebral subgroups	The intervertebral foramen	N=14	57.14±18.02
	The lamina incisure way	N=16	52.47±20.64
Spinal canal type subgroups	Through small articular process inside edge	N=12	68.75±14.63
	The lamina incisure way	N=14	71.78±16.00

Grouping Comparison Results between Group A and B

RF damage rate differences between Intervertebral foramen subgroups, intervertebral pass subgroups in group A and Intervertebral foramen appearance subgroups, intervertebral pass subgroups in group B

(P>0.05) are of no statistically significance; damage rate difference between intra-spinal canal type subgroups of group A and intra-spinal canal type subgroups of group B was statistically significant (P<0.05) (fig. 3).

Table 4: Subtypes Damage Rate of Group C

DRG position type	RF puncture path	Damaged DRG number	Damage degree %
Intervertebral foramen subgroups	The small joints the lateral edge joint through the intervertebral foramen	N=69	82.46±14.10
The pass of the intervertebral subgroups	Approved by intervertebral foramen in combination with the lamina incisure way	N=39	81.53±11.81
The pass of the intervertebral subgroups	Approved by small flange joints inside the lamina incisure way	N=36	80.83±13.33

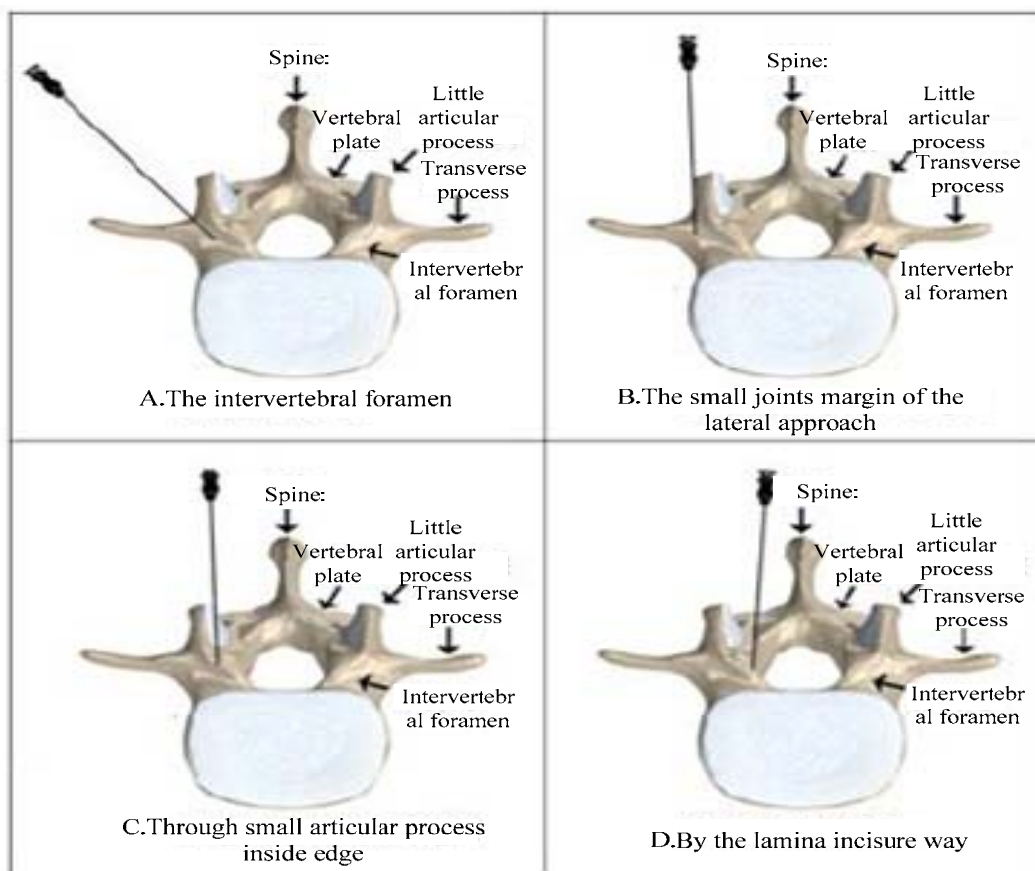


Fig. 1: A, B, C, D four different targeted ways.

Grouping Comparison Results between Two Groups of A and C

Damage rate of the differences in intervertebral foramen subgroups, intervertebral groove type subgroups and spinal canal subgroups between two groups of A and C, were statistically significant ($P < 0.05$) (fig. 4).

Grouping Comparison Results between Two Groups of B and C

Combine the small joints lateral margin approach with intervertebral foramen way is too single, but the damage rate of RF damage will improve obviously if small articular process side of the lateral way or through intervertebral foramen is used to intervertebral foramen exterior DRG, for they are significantly different ($P < 0.05$); join intervertebral foramen way to lamina

incisure way is too single, but the damage rate of RF damage will raise obviously if lamina incisure way or through intervertebral foramen is used to intervertebral groove DRG, for which have significant difference ($P < 0.05$); combine small flange joints inside approach with lamina incisure way is too single, but the damage rate of RF damage will also increase significantly if lamina incisure ways or through small articular process inside edge is used to RF damaged spinal canal type DRG, for they are significantly different ($P < 0.05$) (fig. 5).

In group A, the RF damage rate of intervertebral foramen subgroups, intervertebral groove type subgroups and spinal canal subgroups were respectively $72.58 \pm 18.88\%$, $54.16 \pm 24.84\%$ and $32.85 \pm 28.11\%$; Hint of the low radio frequency (RF) ablation rate from using

intervertebral groove type and spinal canal DRG intervertebral foramen puncture and the wrong choose of the puncture path is one of the important reason for the poor present clinical PHN curative effect.

In group B, the RF damage rate of mall joints of the lateral margin of ways and through intervertebral foramen puncture intervertebral foramen exterior subgroups were $71.86 \pm 15.15\%$ and $72.02 \pm 17.86\%$; the RF damage rate of intervertebral foramen and the lamina incisure way puncture intervertebral pass subgroups were $57.14 \pm 18.02\%$ and $52.47 \pm 20.64\%$; the RF damage rate of Through small articular process inside edge and the lamina incisure way puncture subgroups were $68.75 \pm 14.63\%$ and $71.78 \pm 16.00\%$. Using the intervertebral foramen and through small lateral articular process to radio frequency (RF) damage for intervertebral foramen appearance DRG according to the actual anatomy and clinical cases in clinical use; it is recommended to use he small flange joints inside way and/or the lamina incisure way for radio frequency (RF) ablation to type of spinal canal DRG, for which can effectively increase the damage rate (Meng and Yumei, 2012).

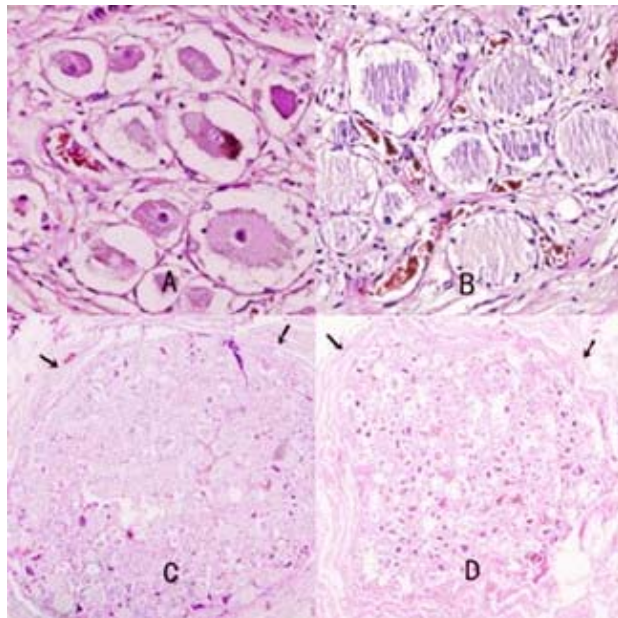


Fig. 2: A (x200) the normal neurons in ganglion; B (x200) as the neuron cell body a coagulation necrosis after radio frequency (RF) ablation, nucleus, cell contour remaining; C D (x40) ratio of damaged neurons inside the nucleus of the ganglion; Black arrow ganglion membrane.

in group C, the RF damage rate of through small articular process the lateral edge joint through intervertebral foramen puncture to intervertebral foramen exterior subgroups was $82.46 \pm 14.10\%$; the RF damage rate of intervertebral foramen way combined the lamina incisure way puncture was $81.53 \pm 11.81\%$; the RF damage rate of through small articular process inside edge way combined

the lamina incisure way puncture to type spinal canal subgroup rate was $80.83 \pm 13.33\%$.

DISCUSSION

DRG is located in the after spinal nerve root, with the primary sensory neurons cell body inside, segmental lumbar and sacral segments for small, including many sensory nerve cells and nerve fibers inside the section. When DRG lesions or stimulated, various sensory disturbance will appear, mainly with nerve root pain. Neuropathy pain is the common clinical rational pain, NP is caused by nerve damage, pain produce from nerve damage (damage sexual stimulation), then through complex signal transduction, and finally produce pain in the brain cortex (Attal, 2012). The clinical symptoms of NP are anesthesia and pain allergic phenomenon in affected same area (Nickel *et al.*, 2012), which badly affected the patient's life quality. As the first level of neurons pain introduced into, DRG plays an extremely important role in the peripheral mechanism of NP. A variety of sensory nerve fibers within DRG, which mainly transfer harmful feelings, thus it is considered to have close relationship with pain. Methods to interrupt DRG sensory signal transmission include drug anesthesia, surgery to cut off the damaged, chemical damage, RF heat was lost by surgery, etc. Among which radio frequency (RF) treatment has advantages of high positioning accuracy, high security, small trauma, good curative effect, fewer complications, and the repeated treatment. It has been widely applied to the treatment of neuropathy pain. At present, radio frequency (RF) treatment has become the first choice for nerve damage to replace other ways (Jiaxiang, 2012).

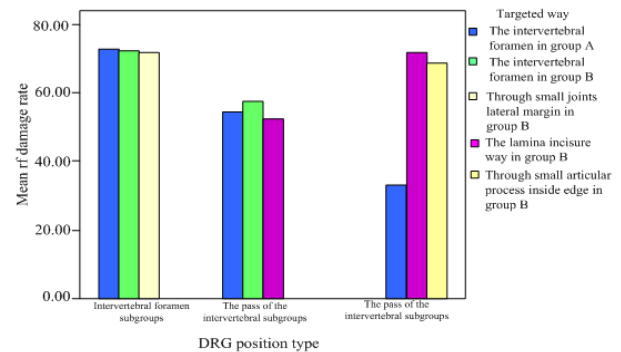


Fig. 3 Damage Rate Comparing Histograms between Two Groups of A and B

Under the C arm guidance, Jin Haibo *et al.* (2011) punctured 16 patients with PHN, a total of 40 DRG, he needle position is on the lateral view after intervertebral foramen ¼ quadrant, and the normotopia is on attachment on both sides of the small joints, after operation the degree of pain was significantly reduced with 11 patients. Use drugs with DRG pulsed radiofrequency therapy on DSA 60 cases of PHN patients, use 15 cm RF needle

puncture to the corresponding segments intervertebral foramen area: before and after a tip lies between transverse process and the end plate, pedicle attachment, side tip is located in outside intervertebral foramen quadrant and lamina ahead. Under the C arm guidance, Xie Zongquan *et al.* (2012) conducted joint sympathetic ganglion DRG RF heat coagulation treatment on 40 patients with PHN, needlepoint aims at the lateral margin of vertebral bodies after a third position of nerve root locations of intervertebral foramen and sympathetic nerve, RF temperature is 85°C, a total of three times, each time is 120s; postoperative associate with Horner's syndrome in 1 case, compensatory hyperhidrosis in 1 case, and still some patients pain can not control ideally. All the above studies adopted blind puncture or simple anatomical marks positioned single intervertebral foramen to RF damage, though it can reaches a certain rate of RF is damaged for intervertebral foramen exterior DRG, but can hardly generate complete damage to the vertebral and spinal canal DRG.

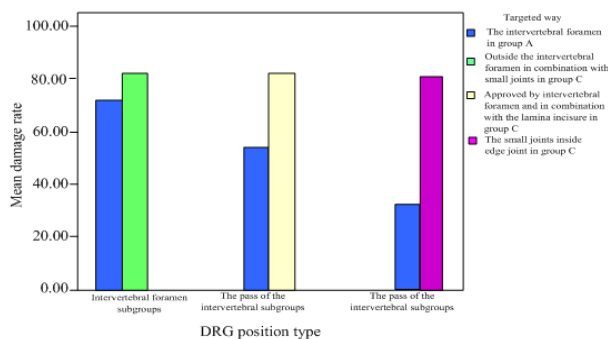


Fig. 4: Damage Rate Comparing Histograms between Two Groups of A and C.

The above puncture route choices are made fully depending on DRG anatomy direction and different position types, results of group B show that for different types of DRG, the rate of spinal canal type DRG RF is damaged can be effectively increased by choosing different puncture approach, but there has no evident improvement for outward appearance and the pass of the intervertebral DRG intervertebral foramen. The spinal canal type DRG is deeply located and close to the dural sac, use the intervertebral foramen way or through small joints lateral margin would be blocked by the vertebral canal bony structure, tip is difficult to directly targeted to the target DRG. While utilize the small flange joints inside and lamina incisure ways would not be blocked by the bony structure around the intervertebral foramen, tip can be targeted to the spinal canal around the DRG, thus it effectively improved the accuracy and the rate of RF damage. For intervertebral foramen exterior DRG, there was no significant piercing damage rate difference by adopting intervertebral foramen way or through small joints lateral margin. So in the clinical, according to the specific situation of the patient, choose more targeted way

for easy operation in view of the intervertebral foramen DRG. Under guidance of CT, Huang Qiaodong *et al.* (2012) conducted thoracic sympathetic nerve radiofrequency thermal coagulation for legacy neuralgia after herpes zoster patients, of which the puncture path is similar to the small joints outer rim, patients get more obvious pain relief after operation. The RF damage rate all have improved significantly by using the small joints joint through vertebral puncture two-way to the outer edge of intervertebral foramen DRG, using approved by intervertebral foramen in combination with the vertebral lamina incisure two-way puncture of approaches to the pass DRG and use the small joints between the medial edge joint by lamina incisure double way puncture pathway to the intra-spinal canal DRG, especially to the intervertebral pass DRG. According to the results of dual puncture group, the intervertebral pass DRG damage rate by a single puncture route has been raised from 52% to 81% by using Dual targeted way (Tanei *et al.*, 2011).

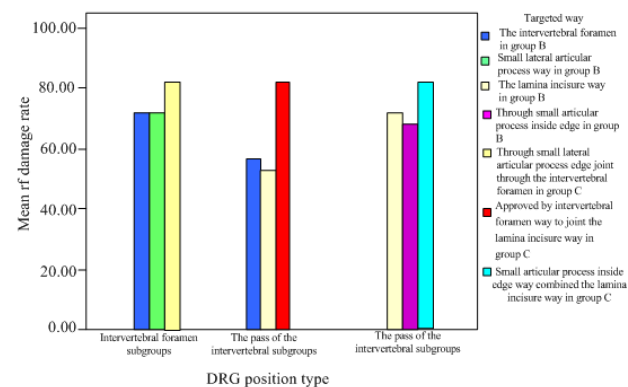


Fig. 5: Damage Rate Comparing Histograms between Two Groups of B and C

Currently the study of DRG for thermosetting radiofrequency ablation, failed to mention the effective image assessment to the preoperative position type of the DRG, nor classify DRG position type, much impossible to select appropriate puncture path according to DRG position type. Especially for spinal canal type DRG, there exists obvious piercing damage rate difference by using intervertebral foramen way with the use of lamina incisure way to intra-spinal canal type DRG. Perhaps this is the reason of poor therapeutic effect in clinical research. At the same time, our experimental results explained that the selection of puncture path directly determines the damage rate of the DRG so mage evaluation is the premise of DRG puncture path selection.

CONCLUSION

In order to choose corresponding targeted way, it is feasible to MRI before DRG radio frequency (RF) ablation and to clear DGR position. Put forward puncture pathways according to different types of DRG for the accordingly different type and suitable way so as to

improve the piercing precision. It is confirmed that using the suitable way of puncture can effectively increase the DRG damage rate and the damage rate caused by using double puncture pathway for radio frequency (RF) damage is significantly higher than using a single puncture pathway.

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