Preliminary Experience of 980nm Diode Laser Treatment for Non-Muscle-Invasive Bladder Tumor with En bloc Technique

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Technical innovations

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Abstract

Background

The disease addiction to chemical substances or drugs such as alcohol (ethanol, \( C_2H_5OH \)) is still not recognised by many medical practitioners as a diagnostic nosology in Ghana. It is usually considered a moral challenge, rather than a medical condition. This perception is propagated even in the Ministry of Health's Occupational Health and Safety (OHS) policy document which punishes symptoms of substance use disorders. This study seeks to explore the perception and attitude of employers towards employees with alcohol use disorders (AUDs).

Method

A qualitative approach of in-depth interviews and observations which described the perceived attitudes of employers (using HR managers as proxy) towards employees with AUD of ten private and public hospitals in the Greater-Accra Metropolis was adopted. The face-to face interviews conducted using a an interview guide were audio-recorded and later transcribed. On average, the interview lasted between 45 and 60 minutes.

Results

Findings from the 10 interviews revealed that psychological factors accounted for AUD regardless of the nature of their work. In spite of prevalence of AUD in some hospitals, it was interesting to know that majority of these facilities had no employee assistance programmes (EAPs) and the few that had some policies on AUD were not implementing them.

Conclusion

This paper focused on some aspect of HR managers’ perceived attitude toward an aspect of their mental well-being which is AUD. However, there are other pertinent issues that are crucial to employee total well-being that can be addressed in future research.

Background

Bladder cancer is the most common genitourinary malignance worldwide, and it is more common in males than in females with a ratio of approximately 3:1. In the United States, an estimated 16,000 bladder cancer-related deaths occurred in 2015. Amongst the 74,000 estimated new cases of bladder cancer diagnosed in 2015, non-muscle-invasive bladder cancer (NMIBC) accounted for approximately 75% [1], and this percentage was even higher among younger patients (< 40 years old) [2]. NMIBC can be treated with endourological procedures.

Conventional transurethral resection of the bladder tumour (TURBT) is one of the most established urological procedures and strongly recommended by guidelines of various countries [3]. However, the
numerous complications, such as bleeding, bladder perforation and obturator nerve reflex, should still be addressed [4]. Lasers are now widely used in urologic surgery. Transurethral laser resection of bladder tumor, using holmium (Ho:YAG) or thulium (Tm:YAG) [5], has been proved to be safe, effective and minimally invasive for NMIBC [6]. Many studies have suggested that laser en bloc resection is superior to conventional TURBT with regard to the decreased complication rate and 24 month recurrence rate. Moreover, laser en bloc resection can provide an accurate tumour stage and grade. [7, 8] A diode laser with wavelength of 980 nm has been reported to provide efficient haemostasis and vaporisation of the prostate [9]. However, studies on bladder tumour are limited. This study aimed to evaluate the efficacy and safety of en bloc transurethral resection of bladder tumor with 980 nm diode laser in patients with NMIBC.

Materials And Methods

Data Collection

From February 2017 to December 2017, 82 patients who were diagnosed with NMIBC and treated by either plasmakinetic transurethral resection (PK-TURBT) or 980 nm diode laser en bloc resection at the Department of Urology, Tangdu Hospital, Air force Medical University were retrospectively analysed. The Ethics Committees of Tangdu Hospiotall of Air force Military Medical University approved these procedures (Approval Number:TDLL-201701-03). The inclusion criteria included clinical stage Ta-T1N0M0, except tumour in situ, recurrent bladder cancer and absence of other tumours. The pathological results were non-muscle invasive bladder cancer, and the diameter of the tumour was less than 5 cm. Clinical assessments were made, which included detailed history, physical examination, blood routine examination, urine routine examination, serum biochemical analysis, coagulation time test, and thoracic, abdominal and pelvis CT scans and CT urography. Cystoscopy and biopsy were performed to determine the location, tumour volume and number of multiple tumours. The preoperative clinical stage was assessed. All patients signed an informed consent form.

The standard procedures were performed in all the operations. All the surgeries were performed by one skilled surgeon in our department. All the patients were in the lithotomy position and under general or continuous epidural anaesthesia. For the 980 nm diode laser group, transurethral laser en bloc resection of the bladder tumour was performed using a 24F continuous-flow cystoscope with 30° lens (Karl Storz, Germany) and 980 nm diode laser surgery system (HU120, Longhuiheng Medical Co., Ltd., China) with an average power of 120 W. Surgery was performed using a 600 µm laser fiber. The procedure is presented as follows. Firstly, we examined the tumour location, volume, appearance, number and adjacent mucosa. Secondly, we made a circumferential incision about 0.5–1 cm away from the boundary of the tumour with a 980 nm diode laser. This step was not necessary for bulky tumours. To treat large tumours, we can start from the accessible tumour boundary (Fig. 1A). Thirdly, the incision deepened progressively into the bladder muscular layer under the tumour. A sharp and blunt dissection was performed between the muscular layer and the serosa of the bladder using the 980 nm diode laser (Fig. 1B). Under the assistance of sheath and water stream, we had an operation space between the tumour base and serosa. At this
point, the tissue mass was completely removed (Fig. 1C). Subsequently, the coagulation of the tumour base and surrounding mucosa was performed (Fig. 1D). Finally, the tissue block was rinsed out of the bladder using Elik’s evacuator or removed by an electrocautery resection loop.

For the PK-TURBT group, a Wolf 26F continuous flow resectoscope with plasmakinetic loop electrode (ScanMed, Zhuhai, China) were used. The cutting and coagulation power of the bipolar generator were set at 160 and 80 W, respectively. All patients underwent traditional piecemeal resection until reaching the muscular layer of the bladder. The resection margin was about 1 cm away from the tumour edge. The tumour base and surrounding mucosa were carefully coagulated, and the tumour was completely resected. The tissue was endoscopically collected by an Ellik evacuator. Pathological assessment was performed by one pathologist with the standard protocol in the Department of Pathology, Tandu Hospital, Air Force Medical University. Eleven of the 53 patients in the PK-TURBT group were excluded from the study due to the lack of muscularis propria in the specimens. Prophylactic bladder irrigation was not necessary for the patients who had clear urine after surgery. The intravesical instillation therapy with 40 mg of pirarubicin was performed in patients without gross haematuria within 24 h after surgery, and it was performed weekly for 8 weeks and then monthly for 10 months. The second TURBT was performed in patients with stage T1 tumours at 6 weeks after the first surgery. All patients were followed up for 2 years, and ultrasound and cystoscopy were performed every 3 months.

**Statistical analysis**

Statistical analysis was performed with SPSS version 19.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were summarised as mean ± SD and analysed by Student’s t test. Categorical variables were analysed using the chi-square test or Fisher’s exact test. P values < 0.05 were considered statistically significant.

**Results**

The clinical characteristics of 82 patients undergoing 980 nm diode laser or PK-TURBT are listed in Table 1. There was no significant difference in the sex, age, mean tumour number and size, tumour multiplicity, location, pathological tumour stage and grade between the two groups.
Table 1
Patient characteristics in 980 nm diode laser group and PK-TURBT group

| variable                          | 980 nm diode laser (n = 40) | PK-TURBT (n = 42) | p Value |
|----------------------------------|-----------------------------|-------------------|---------|
| Sex(n,%)                         |                             |                   |         |
| male                             | 31(77.5)                    | 30(71.4)          | 0.62    |
| female                           | 9(22.5)                     | 12(28.6)          |         |
| Age, mean ± SD (y)               | 68.3 ± 8.4                  | 66.8 ± 7.5        | 0.57    |
| Mean tumor number                | 1.27 ± 0.64                 | 1.24 ± 0.62       | 0.79    |
| Mean tumor size(n,%)             |                             |                   |         |
| ≤ 3 cm                           | 33(82.5)                    | 32(76.2)          | 0.59    |
| > 3 cm                           | 7(17.5)                     | 10(23.8)          |         |
| Tumor multiplicity(n,%)          |                             |                   |         |
| single                           | 32(80.0)                    | 35(83.3)          | 0.78    |
| multiple                         | 8 (20.0)                    | 7 (16.7)          |         |
| location(n,%)                    |                             |                   |         |
| lateral                          | 24(60.0)                    | 23(54.8)          | 0.66    |
| other                            | 16(40.0)                    | 19(45.2)          |         |
| stage(n,%)                       |                             |                   |         |
| Ta                               | 19(47.5)                    | 25(59.5)          | 0.38    |
| T1                               | 21(52.5)                    | 17(40.5%)         |         |
| Grade (WHO2004) (n,%)            |                             |                   |         |
| PUNLMP                           | 12(30.0)                    | 16(38.1)          | 0.73    |
| Low                              | 21(52.5)                    | 20(47.6)          |         |
| high                             | 7(17.5)                     | 6(14.3)           |         |

PUNLMP, Papillary urothelial neoplasms of low malignant potential; PK-TURBT, Plasmakinetic transurethral resection of bladder tumor; WHO, World Health Organization.

Table 2 presents the intraoperative and postoperative characteristics of the two groups. The operation time in the 980 nm diode laser group was shortened (37.7 ± 3.8 vs 39.8 ± 6.9 min, p = 0.09), and the bladder irrigation time in the 980 nm diode laser group was significantly shortened (3.1 ± 0.4 vs 13.1 ± 1.9 h, p < 0.001). None of the patients in the 980 nm diode laser group experienced obturator nerve reflex, while five of 42 patients in the PK-TURBT group experienced obturator nerve reflex during surgery. No
delayed bleeding occurred in the 980 nm diode laser group. However, two of 42 patients experienced delay bleeding in the PK-TURBT group. One patient developed bladder bleeding at 6 h after surgery, and electric cauterisation was needed. The other developed bladder bleeding at 23 h after surgery and was treated by irrigation with ice physiological saline. No patients underwent TUR syndrome, and none of the patients in the two groups needed blood transfusion. The postoperative catheterisation and hospitalisation time showed no significant difference between the two groups. The median follow-up time was 23 months (13–31 months). No significant difference in the recurrence rate was observed between the two groups.

| Table 2 |
|---|
| Intra- and postoperative characteristics in 980 nm diode laser group and PK-TURBT group |

| variable          | 980 nm diode laser (n = 40) | PK-TURBT (n = 42) | p Value |
|-------------------|------------------------------|-------------------|---------|
| Operation time (min) | 37.7 ± 3.8                  | 39.8 ± 6.9        | 0.09    |
| Obturator nerve reflex (n, %) | 0(0)                     | 6(14.3)           | 0.013   |
| TUR syndrome      | 0                            | 0                 | -       |
| Bladder perforation (n, %) | 1(2.5)                   | 3(7.1)            | 0.62    |
| Bladder irrigation (h) | 3.1 ± 0.4                  | 13.1 ± 1.9        | <0.001  |
| Delayed bleeding (n, %) | 0(0)                      | 2(4.8)            | 0.49    |
| Catheterization time (d) | 4.0 ± 0.8                 | 3.9 ± 0.7         | 0.68    |
| Hospitalization time (d) | 3.4 ± 0.6                 | 3.6 ± 0.7         | 0.18    |
| Recurrence (n, %) | 6(15%)                      | 5(11.9%)          | 0.75    |

TUR, transurethral resection; PK-TURBT, plasmakinetic transurethral resection of bladder tumor.

Discussion

Conventional TURBT is one of the most common technique for NMIBC treatment. However, complications such as intraoperative bleeding and obturator nerve reflex often occur [10]. Moreover, the exfoliated cancer cells during operation increase the risk of recurrence and metastasis [11]. Although bipolar resection has been reported to reduce the risk of complications when compared with monopolar resection, the results remain controversial [12, 13].

To overcome the limitations of TURBT, the laser has attracted clinicians’ attention. The first use of laser in urological surgery was reported by Staehler et al. in 1978 [14]. They described the transurethral vaporisation resection of urinary bladder tumours with an Nd:YAG laser. The development of the en bloc technique makes lasers be widely used for bladder tumour treatment [15]. This technique is characterised by high-quality specimens that are beneficial for pathological analysis, in which the detrusor muscle was
found in 96–100% of cases. In addition, laser en bloc resection reduces the risk of scattered tumour cells during surgery [16]. The safety and efficacy of lasers including thulium laser, holmium laser, 2 µm laser and 1.9 µm vela laser have been verified in clinical practice [17–20].

Gregers G Hermann et al. found that the depth and width of 980 nm diode laser are suitable for NMIBC treatment in an in vitro model [21]. Gunnar Wendt-Nordahl et al. found that the 980 nm diode laser shows higher tissue ablation capacity and similar haemostatic properties compared with the potassium-titanyl-phosphate (KTP) laser in porcine kidneys. The depth of the coagulation zones was less than KTP laser, similar to transurethral resection of the prostate (TURP) [9]. A study from Clemente Ramos LM demonstrated that prostate vaporisation using the 980 nm diode laser with output power up to 120 w is effective and related to minimal morbidity [22]. The guideline of laser technique from European Association recommends the use of diode laser treatment as an alternative way to treat patients with bladder outlet obstruction and benign prostatic enlargement. The treatment might have perfect intraoperative bleeding control for patients who have received anticoagulant drugs or had bleeding disorders [23]. To date, no clinical study is available regarding the vaporisation resection of NMIBC with a 980 nm diode laser.

In this study, 40 patients with NMIBC underwent 980 nm diode laser en bloc resection of the bladder tumour. We found that the 980 nm diode laser could provide good haemostatic effects by means of a non-contact point-to-surface pattern for obvious blood vessel bleeding. When the laser came into contact with the tissue, a precise cut with minimal bleeding was made. As a result, the bladder irrigation time was significantly shortened, and none of the patients in the 980 nm laser group experienced delayed bleeding. The vaporisation and cutting effects of the 980 nm diode laser were perfect. As shown in Fig. 1, the 980 nm diode laser controlled depth and width of cutting, as well as precise excision of the complete areas between the deep muscle layer and serosa layer. No complications of heat injury occurred. As previous literature described, the first step of laser treatment is making a circular incision in the mucosa around the tumour. However, we found that this step was difficult or unnecessary in bulky tumours or some special locations. In our opinion, the resection can start from the accessible tumour boundary, cut into the muscular layer and then gradually expand in the areas between the muscular layer and the serosa. With the assistance of the sheath and water stream, we created an operative space between the tumour base and the serosa. The tumour was completely removed, thereby maintaining the integrity of the tumour. The bulky tumour could be easily removed from the bladder using the electrocautery resection loop. The accurate pathological results were obtained (Supplementary Fig. 1). In this study, a total of 11 patients receiving TURBT treatment were excluded because no muscularis tissue was found in the specimen. The 980 nm laser is safe to deal with the tumour in the lateral wall of the bladder for without obturator reflex occuring. In addition, there were some advantages compared with other lasers. The diode laser lacks a steam bubble effect similar to holmium and thulium lasers, which create steam bubbles whose energy may destroy tissue and affect visibility of operator [24]. And diode lasers have a smaller box size and a much higher wall-plug efficiency, i.e., how much of the main supply is converted into laser power, and a lower price[23].
There are some limitations in our study, including its retrospective nature and small sample size. And we investigated the patients treated in one hospital. The way in which the patients were enrolled may have introduced selection bias. Further prospective research needs to be carried out in the future.

In conclusion, 980 nm diode laser is an efficient and safe tool in transurethral resection of NMIBC using the en bloc technique. It has less perioperative complications and shortened bladder irrigation time compared with PK-TURBT.

**Abbreviations**

TURBT: transurethral resection of the bladder tumor; NMIBC: non-muscle-invasive bladder cancer; TUR: transurethral resection; ONR: obturator nerve reflex; Ho:YAG: Holmium; Tm:YAG: thulium; PK-TURBT: plasmakinetic transurethral resection of bladder tumor; KTP : potassium-titanyl-phosphate; TURP: transurethral resection of the prostate;

**Declarations**

**Acknowledgment**

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**Authors’ contributions**

MTC and ZHY contributed to data collection and analysis, and manuscript writing. CJ and YFQ contributed to the data collection and manuscript writing and revising. HKH contributed to the data analysis and manuscript editing. SJB and ZW contributed to the study design, data analysis, and final approval of manuscript. All authors read and approved the final manuscript.

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**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Ethics approval and consent to participate**

The Ethics Committees of Tangdu Hospital of Air Force Medical University approved these procedures (Approval Number:TDLL-201701-03).
Consent for publication

Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient/parent/guardian/relative of the patient.

Competing interests

The authors declare that they have no competing interests.

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**Figures**

![Figure 1](image)

**Figure 1**

The surgery procedure of 980nm diode laser en bloc resection of bladder tumor. (A) A circumferential incise was made about 0.5cm-1cm away from the boundary of tumor. (B) The incision was deepened into
the bladder muscular layer under the tumor. Then sharp and blunt dissection was performed between the muscular layer and the serosa of the bladder. (C) The incision was made along the layer between the muscular layer and the serosa of the bladder. Lastly, the tissue mass was completely removed. (D) The tumor was en bloc resected, and the wound surface was observed.

**Supplementary Files**

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